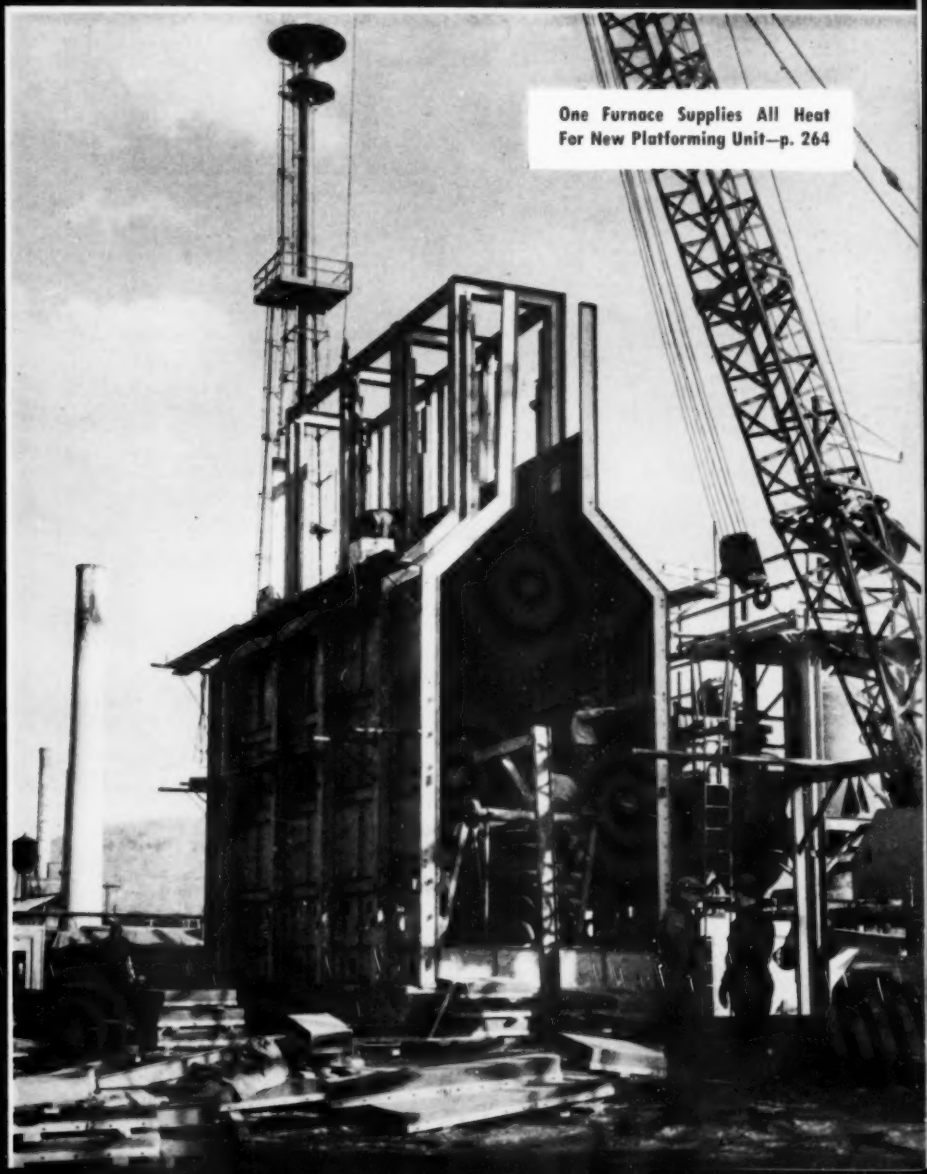
MARCH, 1951
VOL. 6, NO. 3

PETROLEUM PROCESSING



One Furnace Supplies All Heat For New Platforming Unit—p. 264

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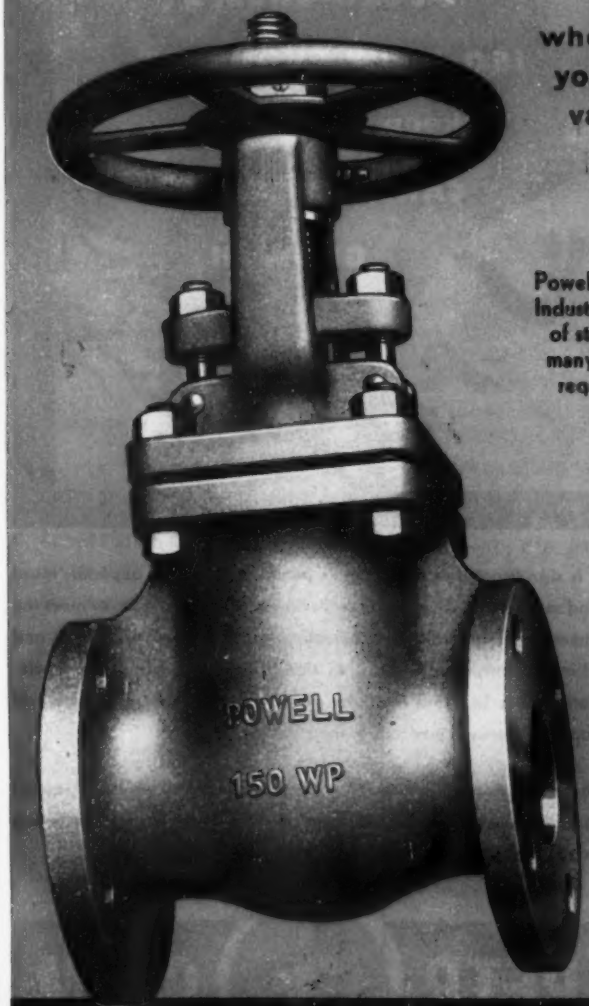

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Quality first throughout "The Line"

New 150-pound O. S. & Y. Gate Valve. Available in a wide selection of corrosion-resisting alloys. Made with either flanged or screwed ends. Sizes ¼" to 2", incl. All dimensions of flanged end valves conform to MMS Standard SP-42 and ASA B16.

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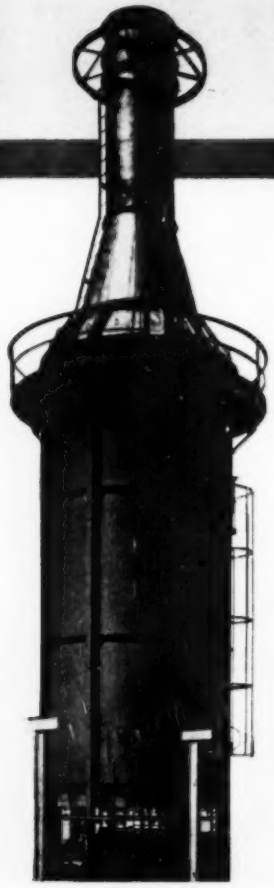

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 (To obtain more data on advertised products see page 312)

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Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

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A Platt Petroleum Publication

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Published second Tuesday of each month by National Petroleum Publishing Co., 1213 West Third St., Cleveland 13, Ohio. Subscriptions: $8.00 a year in U.S. and possessions, $8.50 a year elsewhere. Single copies, 75 cents each; back copies more than three months old, $1.00 each. Published prior to Sept., 1946, as the *Technical Section of National Petroleum News*, devoted to Refinery Management and Petroleum Chemical Technology, and including *International Petroleum Technology*. Trade mark registered U.S. Patent Office. Copyright 1951 by National Petroleum Publishing Co. Acceptance under the act of June 5, 1934, at Cleveland, Ohio, authorized Dec. 22, 1948.

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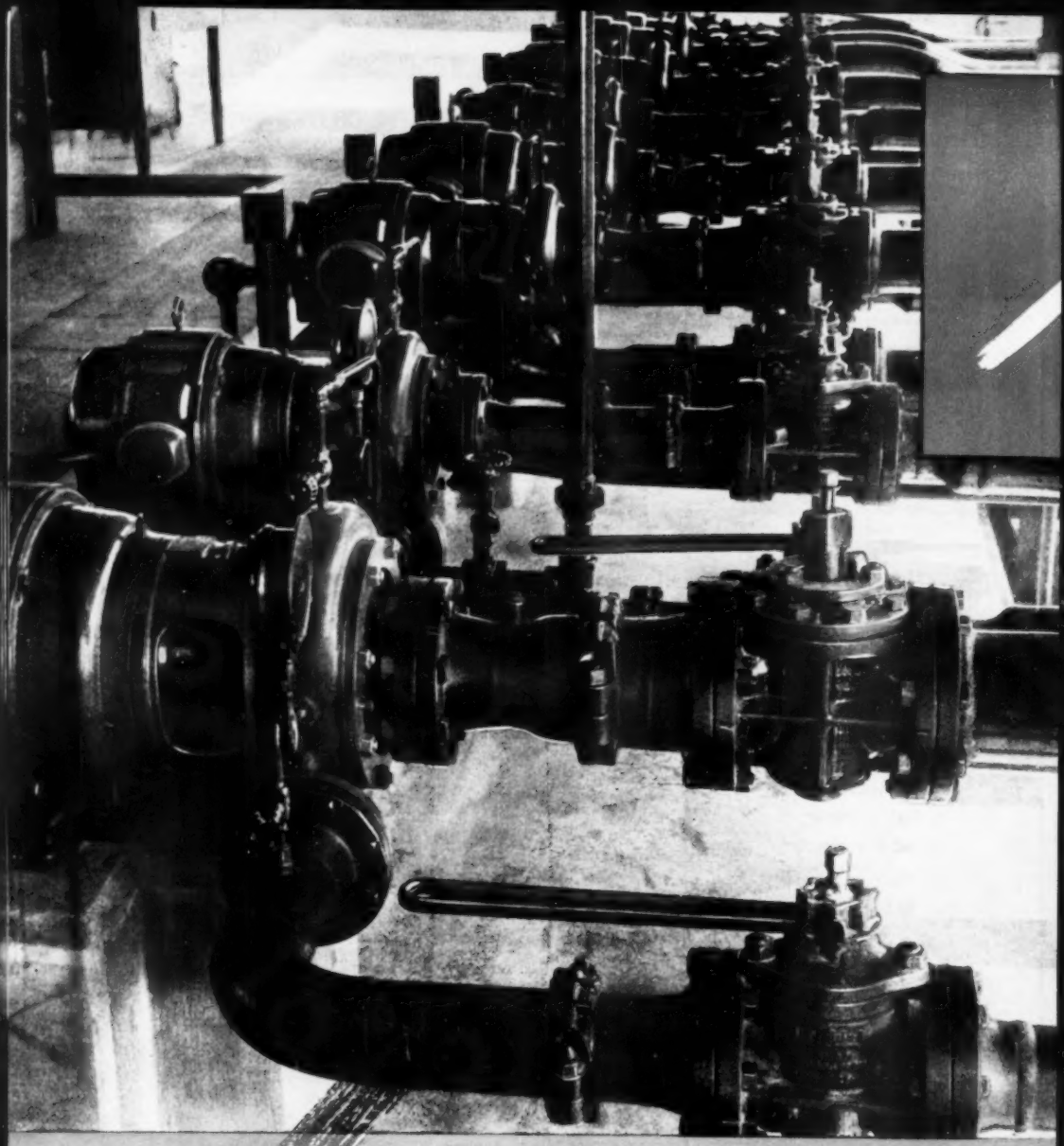

CHECK ALL PUMP CONNECTIONS . . .

Adopt this new habit

OF VALVE REPLACEMENTS ON ALL PUMP CONNECTIONS

Valve failure on pump lines is a hazard, especially in closed areas and where every precaution must be taken to avoid disaster. Some operators follow an old and dangerous habit of merely replacing a troublesome valve with a like valve, assuming that the new "old" valve will be a remedy. But if the old valve were right in the beginning it probably wouldn't need replacing.

Get the new, improved habit—replace with Nordstroms. Recheck each valve on your pump connections. Requisition Nordstroms. Make this standard practice—and eventually you'll have a really up-to-date set of valves that will end your valve problems permanently.

Nordstroms save space in restricted pump locations. They give positive shut-off because a quarter turn of the plug is an absolutely sure operation as contrasted with a valve dependent upon an exposed disc and seat that must be jammed together.

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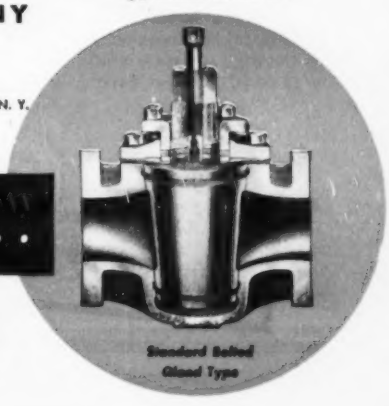
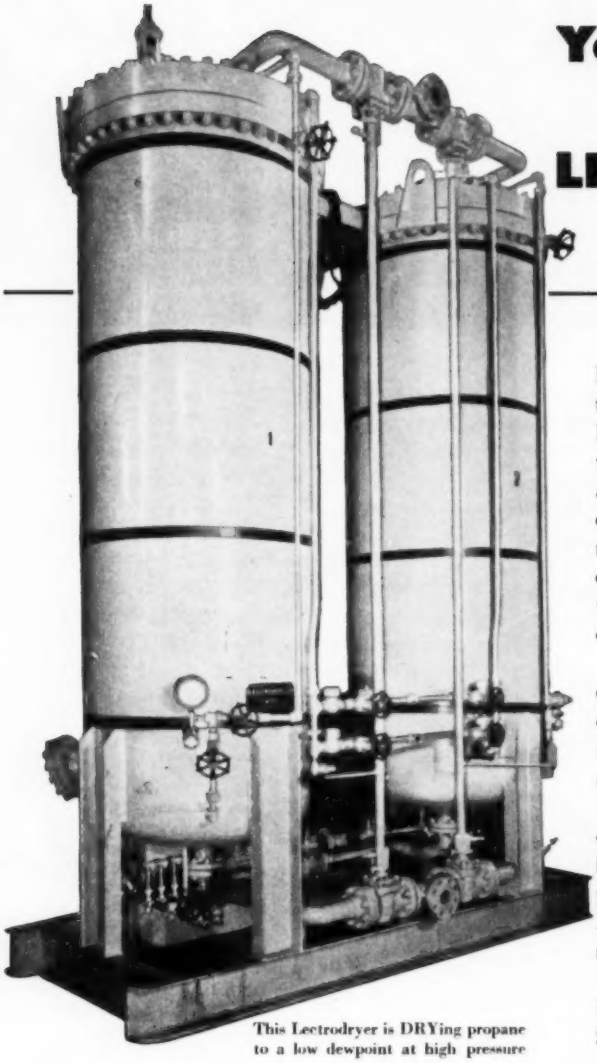


Standard Bolted Gland Type

. . . FOR REPLACEMENTS AND . . .

to avoid hazards of leakage

INSTALL NORDSTROMS



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WHAT'S HAPPENING

Current News Summarized For Oil Men

EXPANSION

Canadian Oil Companies, Ltd., will add a 3800 b/d Platforming unit to facilities at its 20,000 b/d $18 million refinery now being built at Froomfield, Ont. (see PP Oct. p.1019, Jan. p.7). Universal Oil Products Co. will design the unit with actual construction to be handled by Procon, Inc., UOP construction subsidiary.

Atlantic Refining Co. is building an 11,000 b/d catalytic reforming unit at its Philadelphia plant to utilize company's newly-developed process described on p. 249 of this issue. Cost of new unit is estimated at $4-5 million, with construction contracts to be let shortly for planned completion in early 1952.

Cities Service Oil Co. plans to install grease making facilities at Chicago capable of producing 8.5 million lbs. of grease annually, using a modification of the Stratco (Stratford Engineering Co.) process. Peak loads of 150% of rating will be possible for short periods. Installation will be directed by Cities Service Engineering Dept. with completion scheduled by end of 1951.

Costs of an additional 1,000,000 b/d capacity in the Western Hemisphere, in terms of finished products, are being studied by a 23-member industry committee appointed by National Petroleum Council. Chairman is Robert E. Wilson, of Indiana Standard. Committee will determine capital and material requirements for the additional million barrels of capacity, including refining facilities, crude supply, transportation and storage. Eugene Holman, Jersey Standard, heads Refining subcommittee.

• • •

MARKETS, PRICES

Full demands of fuel oil customers were met during February, but only after overcoming serious dislocation of supplies in the Midwest and Mid-Continent. A general scarcity of tank cars in the Midwest was aggravated by a wildcat railway switchmen's strike with the result that the North Central areas of the nation were clamoring for more fuel oil and refiners in the Mid-Continent and Southwest were forced to delay shipments from their ample supplies for lack of transportation.

Rapid depletion of refinery stocks of kerosine and No. 2 fuel pointed to heavier than usual demands, although there were signs toward the end of the month of the demand easing. Bunker "C" demand showed no signs of letting up at the Gulf or along the Eastern Seaboard, although larger offerings than previously were beginning to appear in the Mid-Continent. Gasoline inventories were at all-time peaks, but this was no cause for worry among refiners; while some said they might run into storage difficulties before the spring season starts, refiners generally agreed they'd need all the gasoline they could make.

Lubes, petrolatums, waxes and specialty products continued to be snapped up by eager buyers whenever these products appeared in offerings on the general market. Containers hampered some refiners in making shipping schedules, particularly for lubes and petrolatums, but buyers were more than willing to take these materials in bulk when packages were not obtainable.

• • •

FOREIGN

Standard-Vacuum Oil Co. plans to start construction early next year of a 10,000 b/d refinery at Durban, Union of So. Africa, which will cost about $12 million. It will be the first plant in the Union to operate on imported crude oil, and will supply South African market. Completion will be late 1953 or early 1954.

Gewerkschaft Erdol-Raffinerie Emsland will install the first Houdriflow catalytic cracking unit to be built in Europe, at its new refinery at Lingen, Germany, near the Dutch border. Unit's capacity will be between 10,000 and 15,000 b/d, according to Houdry Process Corp., licensors. Only other catalytic cracking plant in Europe is a fixed bed Houdry unit at Derre, France.

• • •

PETROCHEMICALS

Gulf Oil Corp. will build the world's largest single unit for manufacturing ethylene at its Port Arthur, Texas, refinery. It will have a capacity of 2½ bil-

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

lion cu. ft. annually, or about 12% of present U. S. ethylene capacity. Feed stock will be gases from Gulf's nearby refinery, which will be cracked and purified. Lummus Co. has contract, with construction scheduled to begin by April, and completion expected early next year.

British American Oil Co. and Shawinigan Chemicals, Ltd., shortly will form a jointly-owned petrochemical company which will make "certain basic chemicals now in great demand." Plant construction is expected to start within a few months, probably in Montreal area.

Sinclair Refining Co. has created a new petroleum chemicals division as initial step in enlarging company's activities in petrochemical field. J. A. Scott, formerly assistant to the vice-president, R&D, is manager.

• • •

TRANSITION

Petrol Refining, Inc., has changed its name to Texas City Refining, Inc., effective Feb. 23.

Agua Dulce Co. of San Antonio has been sold to H. J. Mosser, Alice and Ft. Worth and C. H. Fisher, Corpus Christi, including the Banquette cycling plant (near Robstown, Tex.) of the Henderson Trusts, San Antonio. New owners plan an immediate construction program to more than double the present 50,000 Mcfd. capacity of the Banquette plant and related facilities.

• • •

INDUSTRIAL MOBILIZATION

Allocation of tetraethyl lead fluid became effective March 1. Under allocation system each refiner has a base allotment of 1,000,000 lbs. of TEL fluid per year, or such smaller amount as he may have used in 1950, plus 80% of amount in excess of 1,000,000 lbs. used in 1950.

Allocation plan is aimed at building up a reserve supply of TEL for military avgas, and substitutes for earlier plan to limit octane ratings on motor gasoline —which met strong objections from many segments of industry. (Write PP's editors for copy of PAD's "Order No. 1" establishing allocation.)

Effect of TEL allocation may be to reduce octane ratings of all motor gasolines by 1 to 1.5 numbers, PAD believes, if cutback is applied across-the-board by all refiners. Allocation order, however, establishes no ceilings on octane ratings and leaves each refiner free to use his allocation in any manner he chooses in motor gasoline production.

Provision is made in allocation order for any refiner to request an adjustment or exception on the ground that "his operations were commenced, increased or altered during or after the base period or that any provision works as undue or exceptional hardship upon him not suffered generally by his competitors or others in the same trade or industry."

Supplies for maintenance, repair and operation (MRO) and for minor capital additions may now be secured in limited quantities under a new NPA priority system authorized Feb. 27. Supplies may be obtained in the same dollar amount spent for such supplies in 1950. Minor capital additions are defined as "any improvement or addition carried as capital according to established accounting practices when the total cost of materials used does not exceed $750 for any one complete capital addition."

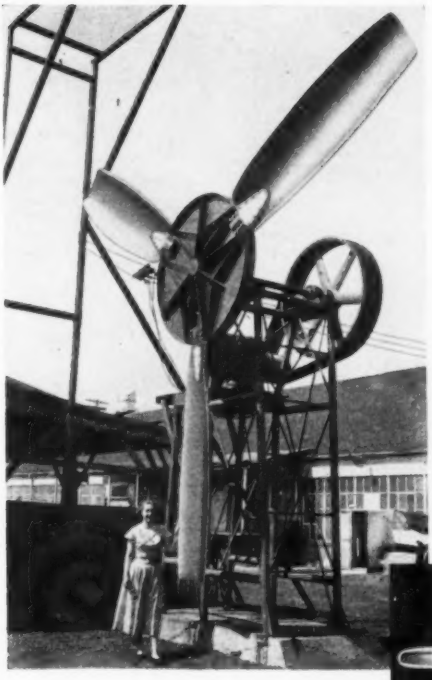
New MRO order (NPA Reg. 4) applies to all establishments and persons, including refiners and similar operators. MRO ratings will be designated as DO-97 and will have equal preference with DO ratings used for handling defense orders.

To apply new priority rating it is only necessary when placing an order for MRO or minor capital addition to place on the order or on a separate piece of paper clearly identified with the order the symbol "DO-97" together with words "Certified under NPA Regulation 4" and the signature of person doing the ordering. No other NPA authorization is needed. (Write PP's editors for copy of NPA's "Reg. No. 4" establishing MRO priority system.)

PAD's own MRO program was said to be about ready for announcement at the time NPA's program came out. Nothing further on it had developed, however, at PP press time—March 2. Refiners will have choice between upcoming PAD program tailored especially for the oil industry and NPA's general MRO program. PAD's program will probably afford more "flexibility" since it will not employ the quota provisions set out in NPA program.

APPOINTMENTS—A. P. Frame (Cities Service) as PAD's assistant deputy administrator for domestic industry operations. Activities of all PAD divisions effecting domestic operations—including refining, supply and transportation, materials, etc.—will be under his general supervision . . . **R. H. Hargrove** (Texas-Eastern Transmission Corp.) as PAD's acting assistant deputy in charge of transmission and distribution of gas . . . **N. W. Freeman** (Tennessee Gas Transmission Co.) as acting director of PAD's gas division . . . **Justin R. Wolf**, as general counsel of PAD; he has been in private law practice in Washington since World War II . . . **Edwin T. Gibson** (General Foods) as deputy administrator for staff services of Defense Production Administration. He will assist in coordinating operations of other defense agencies over which DPA has over-all policy-making jurisdiction, including PAD . . . **Kyle P. Laughlin**, former consultant to Defense Secretary Marshall, as director of Federal Civil Defense Administration's Fire Service Division.

From 3 to 22 Feet



There's a Hartzell Cooling Tower Fan Exactly Suited to Your Needs . . .

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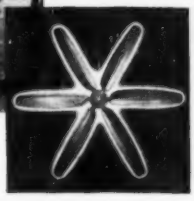

THIS "LITTLE" 3-FOOTER PUTS EXTRA CAPACITY INTO SMALLER TOWERS

Hartzell cooling tower fans are built to give you the size and capacity you need — from 3-foot diameter to 22-foot. And at every size level you'll get *more* . . . more capacity per cubic foot of tower . . . more flexibility, because air deliveries can be changed if your requirements should change . . . more years of life, because Hartzell cooling tower fans withstand vibration, corrosion, abrasion and other factors of deterioration.

For instance—the Hartzite plastic of which Hartzell fans 10-feet and larger are made *has no fatigue limit;* cut it and the cut will not develop into a major fault. Even wilful abuse — foolishly high speed, excessive vibration and so on — will damage it much less than experience with less rugged materials would indicate. And in sizes smaller than 10 feet the special Hartzell aluminum alloy does a mighty fine job.

In *every* size, Hartzell fans give you maximum air per power dollar. *They pay out.*

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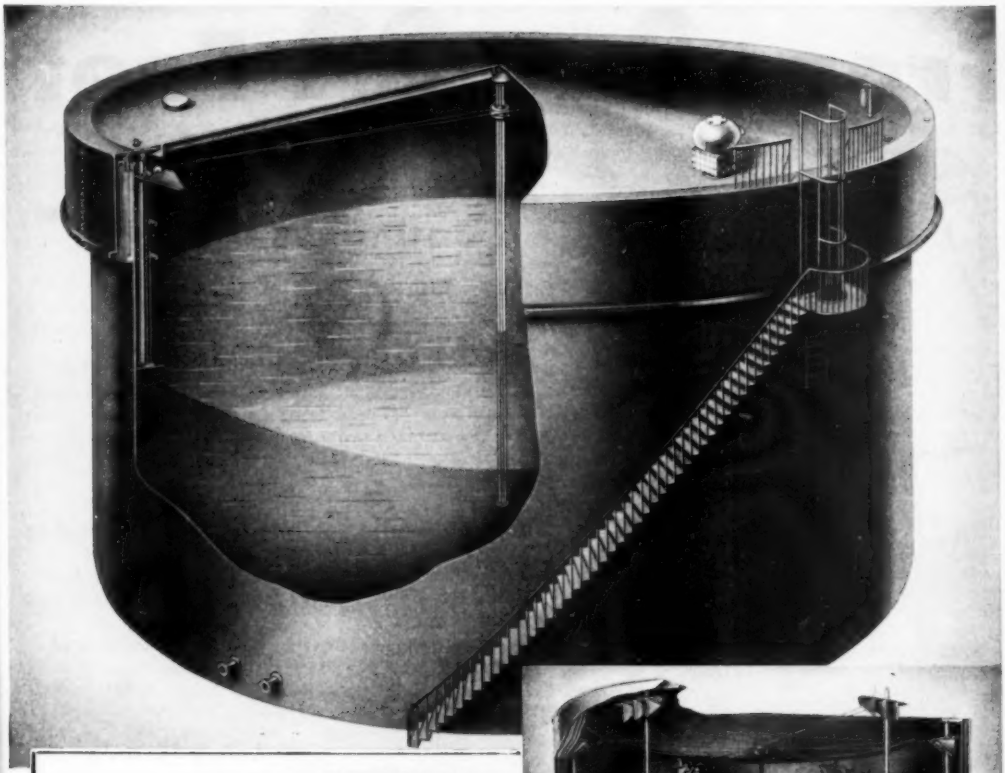
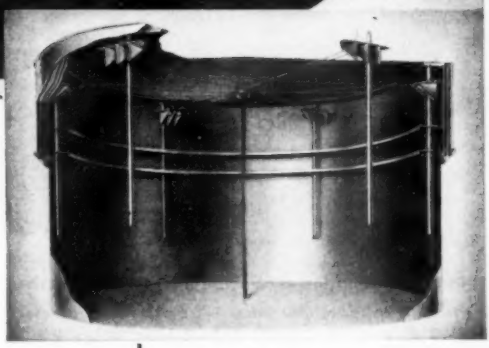
(To obtain more data on advertised products see page 312)



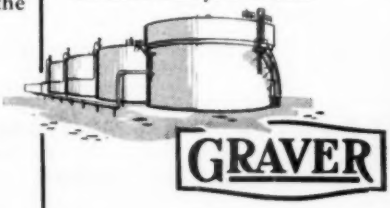
INSIDE STORY

ON VAPOR-SAVING WITH THE GRAVER EXPANSION ROOF



Cut-away for your inspection is this Graver Expansion Roof Tank. Here you see the details of its operation which dependably conserves the volatile elements of gasoline . . . so critically important today! This Graver design—approved by Underwriters' Laboratories—has a record of unfailing operation throughout the petroleum industry during the decade since it was first introduced.

Inset above shows mechanism by which *all-weather* stability is attained in the Graver Expansion Roof. The functional perfection of this design keeps *Conservation at Work* day and night in any climate . . . all year 'round.



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GRAVER

TOMORROW... IN PETROLEUM TECHNOLOGY

Possible Effects of Today's Developments On Future Operations

By the Editors of Petroleum Processing

Catalytic Cracking Top Process Weapon of Defense

THE significance of the catalytic processes now used in the refining of petroleum and our dependence on them to meet the requirements for high grade aviation gasoline in the event of another war is appraised by Foster Wheeler Corp. in a recent bulletin.[1] Chief of these processes, of course, is catalytic cracking, which is described as "one of the most valuable process weapons of defense". In the event of another war many small catalytic cracking units would be built, it is predicted.

The 500,000 b/d of 100-octane "avgas" produced in World War II was chiefly possible through the effective conservation and utilization of high-octane intermediates from all sources. A significant proportion of these was obtained from thermal cracking, thermal reforming, superfractionation, selective polymerization for the production of codimer, and the hydrogenation of the codimer to the hydrocodimer.

"These processes are no longer the most efficient means of producing high-octane intermediates", the report continues, "being generally considered obsolete for that purpose today except in remote areas where the different catalysts would not be readily available.

"The five major processes that would be used in an all-out effort to produce the maximum quantity of 115-145 octane aviation gasoline are catalytic cracking, catalytic reforming, catalytic alkylation and isomerization, and catalytic aromatization". Of these alkylation is regarded as most significant, since it provides for the utilization of butylene, available from many non-catalytic, as well as catalytic, sources for the manufacture of alkylate.

In the past 10 years, it is pointed out, considerable improvement has been recorded in the techniques of the several methods of catalytic cracking, and further improvements are about to emerge from the laboratory and pilot plant into practical operation in the refinery. "The most significant reflection of this process of evolution is the fact that the investment cost of a catalytic cracking unit has been so greatly reduced that it is available to the small refiner in capacities as low as 1000 b/d. This, of course means that in the event of an all-out effort to produce higher-octane aviation gasoline many small catalytic cracking units would be built."

So great has been the technological progress since the last war, the report concludes, that should a major conflict arise, the record of the last war, 500,000 b/d of 100-octane gasoline, could be exceeded in both volume and quality.

No Standard Method for Evaluating Crude Oils

AS a part of its extensive program for the standardization of oil testing methods, the British Institute of Petroleum, the sponsoring agency in that country, undertook in 1948 to evolve a standard technique for the evaluation of crude oil for purposes of refining into conventional products.

In a recent report on its work[2] the I.P. Standardization Sub-Committee No. 2—Crude Oil states: "It was soon realized, however, that owing to the diverse characteristics of crude oils and to the fact that many oil companies had evolved their own methods of crude oil evaluation, it was impracticable to specify a rigid procedure to be followed in all cases."

This conclusion resulted in the withdrawal from the Institute's Standard Methods[3] of the earlier proposed method for the Distillation of Crude Petroleum. While it is possible, the report states, by simple methods such as I.P. 24 to detect major differences between crude oils, experience has shown that such methods of evaluation are totally inadequate for complete crude oil evaluation.

The technologists in charge of this phase of the British standardization program decided, however, that it was desirable to publish a paper[2] setting out the principles involved in the laboratory evaluation of crude oils, suitable types of equipment to be used and so on, thereby indicating methods for the individual refiner to use in judging whether a given crude oil was suitable for his refining procedures or indicating the changes advisable if the crude were to be processed.

While acknowledged as unsuccessful in its original purpose, the report will be of interest to U. S. refiners, who also have not been able to work out a standard technique for evaluating crudes, and it is a contribution to the literature on the principles involved in the task.

Non-Metallic Materials Might Be Answer to Drum Shortage

LOOK for a growing interest in non-metallic packaging — plastic drums, synthetic rubber tanks, glass fiber-lined containers, as the current situation continues to make inroads on steel output.

Latest development is a 55-gal, fiber drum package lined with a polyethylene envelope for shipment of non-corrosive, non-flammable liquids.[4] Advantages cited include ability to withstand shipping abuses, a tare weight 50-75% less than that of conventional containers, ability to open and re-seal container while still protecting contents, and no metal requirements. A Rohm & Haas Co. patent[5] covers this new package; however, they are not selling the drum. Rather, it will be licensed to responsible shippers to assemble at a nominal fee. Licensees can buy component parts of the package from suppliers of their own choice. Following companies cooperated with R&H in the development: Continental Can Co., Inc.; Visking Corp.; Shellmar Products Corp.; Kellogg Container Div. of U. S. Envelope; Hedwin Corp.; and Cincinnati Industries, Inc.

This package would seem to have little use at present stage of development for most petroleum products except high flash point materials and specialties in the petrochemical line.

However, it is further indication of a trend demonstrated by earlier reports of two other containers. One is a collapsible gasoline storage tank of 10,000 gal. capacity developed by the government's Engineer Research and Development Laboratories at Ft. Belvoir, Va. and made by Goodyear Tire and Rubber Co.[6] Resembling a giant pillow when full and a rug when empty, it is made of Buna N synthetic rubber, reinforced with inner and outer layers of nylon cloth formed into a 3/32-in. coat, a liquid coating of nylon to serve as a porosity barrier, and a layer of Buna N in contact with the gasoline.

Though production of 900 and 10,000-gal. models so far is tagged entirely for the military, Goodyear spokesmen see no immediate reason why such containers could not be produced for civilian use.

Another collapsible drum or tank under current development uses special Neoprene sealing method for assembling laminated Fiberglas segments into cylindrical containers.[7] Maurice Moore, president of Rich-

mond Oil Equipment Co. and inventor of the sealing method, foresees its application to 55-gal. drums, small storage tanks, or field-erected tanks of "unlimited" capacity. Glass fiber construction with Neoprene seal provides complete resistance to any petroleum hydrocarbons, high tensile strength for protection against breakage. Collapsibility feature means returnable empty drums can be shipped at same rail or truck rate as flat steel, parts can be cleaned more rapidly than conventional drums, and unskilled labor can assemble both drums and tanks.

The significant point for the future to consider about these developments is that success of such non-metals may eventually supplant steel as a permanent thing.

Anti-Icing Additives Are New Gasoline Refinement

FROM time to time fresh evidence comes to light to show the many and varied performance requirements which the motor gasolines of today have to meet. A report presented before the recent annual meeting of the Society of Automotive Engineers, in Detroit,[8] brought out that carburetor icing, under certain atmospheric and high humidity conditions, resulting from the refrigerating effect of the evaporating gasoline, is becoming a more prevalent nuisance factor in driving, through causing engine stalling during the warmup period. This condition is being met through the use of new gasoline additives, developed to meet this requirement, without otherwise affecting fuel performance.

The phenomenon of carburetor icing is by no means new, but a number of factors today contribute to make the motorist more aware of the poor idling performance of his car, which to a large extent is attributed to this cause. Among these factors are lack of a manual throttle control on cars made since World War II, to allow the driver to step up his idling speed and thus avoid stalling; slower idling speed of cars with automatic transmissions, which makes it easier for them to stall, and the inconvenience to the driver of a car with automatic transmission of restarting his engine after a stall.

The Standard Oil Development Co. research staff, after determining the extent of the time in the fall, winter and spring, over the country when temperature and humidity conditions are conducive to carburetor icing, undertook to find a remedy. "Neither the reduction of gasoline volatility nor the application of additional heat to the carburetor are satisfactory methods for the elimination of ice formation in the carburetor", they reported.[8] "It appears, therefore, that a practical and economical method of reducing car sensitivity to carburetor ice formation lies in the field of gasoline additives".

The additives developed to the commercial stage by this company to reduce carburetor icing are understood to be anti-freezing materials derived from petroleum. They accomplish their purpose by reducing the temperature at which the water in the air stream in the carburetor will freeze. They are said to have no adverse effect on parts of the fuel system and to cause no increase in fuel or induction system deposits. Their use in gasoline is also said to tend to prevent freezing of liquid water in the fuel system, thus avoiding fuel line freezing in extremely cold weather.

"Care and judgment must be exercised in the selection of the compound and the concentration in use, since many compounds suitable as anti-icing agents may be entirely unsuitable in other respects, particularly as to the formation of fuel or inducting system deposits."

Heat with Liquids for Better Products at a Lower Cost

CONVENTIONALLY, petroleum process fluids are heated in furnaces which are essentially heat exchangers with the fluid on the inside of the tubes and the heat transfer medium on the outside in the form of a gas or vapor; i.e., combustion gases. Known shortcomings to this practice have been non-uniformity of surface, or "skin" temperatures, relatively low efficiency in heat transfer, and lack of precise control of the temperature. The same problems exist in lower temperature processes where steam vapor is the heating medium.

Recently, the use of liquid rather than gas or vapor as the heating agent has been gaining in popularity, particularly in the medium temperature ranges, say up to about 600° F. For example, Standard Oil Co. (Ohio), at its new lube oil plant in Lima, Ohio, employs circulating hot gas oil systems to supply all heat requirements for its furfural extraction and MEK dewaxing units.[9] Designed by Lummus Co. engineers, these so-called "hot belt" systems replace the fired heaters normally employed, and avoid the detrimental effects on the oil of high skin temperatures existing in the tubes of a fired heater.

Compared with liquids in the transfer of equivalent amounts of heat, gases or vapors require large ducts to circulate the large volume needed in the transfer of the heat energy. Specific heats and film coefficients of gas are low. Power consumption is high, and uniform surface temperatures generally unattainable, according to one authority.[10]

Liquid flowing through a pipe, on the other hand, has, at a given cross section, the same heat transfer coefficient at any point of the periphery. Variations occur only in an axial direction. By keeping inlet and outlet temperatures close, temperature variations in the system can be reduced to only a few degrees.

A wide variety of liquids can be utilized as heating media. Water is cited as a good one up to 400° F. Heat carriers for the range 400-700° F. include mixtures of diphenyl and diphenyl oxide (Dowtherms), petroleum oils, and non-flammable chlorinated biphenyls (Aroclors and Hydrotherms). From 700-1000° F., molten inorganic salt mixtures are indicated; for example, sodium nitrite and potassium nitrate (Hydrotherm 1200, Hi-Tec, Beth-Tec).[10, 11] Possible future heat carriers being studied include fluorine compounds, glycols and their derivatives, and the silicones, which show the most promise.

An interesting feature in addition to process efficiency is low fuel costs. This same authority[10] gives these comparisons:

The over-all efficiency of liquid heating systems, based on the experience of existing installations, is approximately 70% at a fluid temperature of 500° F. Assuming a No. 6 fuel oil price of 6c/gal., the resulting fuel cost would be 57c/million Btu./hr.

Equivalent high pressure steam systems operate at over-all efficiency of 50-60%, and result in fuel costs of 66 to 80c/million Btu./hr. With electricity, assuming an efficiency of 98% and cost of 2c/kwh., the corresponding expense would be $5.80/million Btu./hr.

In all likelihood, design engineers in the petroleum industry will find it worth their while to pay increasing attention in the future to this method of heating process fluids—to achieve more precise process control if for no other reason.

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(11) "Develop New Heat Transfer Unit Using Inorganic Salt Mixtures," William C. Uhl, PETROLEUM PROCESSING, Vol. 3, No. 1, p. 65, January, 1948.

Five Santolubes to improve premium and heavy-duty oils

Added to your premium and heavy-duty lubricants, the Monsanto Santolubes, listed below, help your products deliver top performance. These Santolubes have two functions: (1) to inhibit oxidation; (2) to keep motors clean. For information write MONSANTO CHEMICAL COMPANY, Petroleum Chemicals Department, 1700 South Second Street, St. Louis 4, Missouri.

SANTOLUBE 379

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	0.97
Viscosity, S.U.S. at 210° F.	53
Color, ASTM (diluted)	4½
% Phosphorus	0.6
% Sulfur	5.7
% Barium	3.8

Applications: Motor-oil additive which combines the properties of detergency, dispersancy, corrosion inhibition and pour-point depression.

Literature: Technical Bulletin No. 0-68

SANTOLUBE 360

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	0.97
Viscosity, S.U.S. at 210° F.	50
Color, ASTM (diluted)	3
% Phosphorus	0.5
% Sulfur	5.1
% Barium	4.0

Applications: A multifunctional agent, combining, in a single additive, detergency, dispersancy and corrosion inhibition. An effective pour-point depressant.

Literature: Technical Bulletin No. 0-66.

SANTOLUBE 388

Type: Detergent-dispersant-inhibitor type additive.

Typical Properties:

Specific Gravity at 60°/60° F.	1.00
Viscosity S.U.S. at 210° F.	55
Color ASTM (diluted)	5
% Phosphorus	.5
% Sulfur	5.4
% Barium	6.1

Applications: Heavy-duty oil additive. Suitable for meeting current military specifications.

SANTOLUBE 374

Type: Detergent-dispersant-inhibitor type additive

Typical Properties:

Specific Gravity at 60°/60° F.	0.98
Viscosity, S.U.S. at 210° F.	50
Color, ASTM (diluted)	5
% Phosphorus	0.8
% Sulfur	6.6
% Barium	3.6

Applications: A single motor-oil additive that combines detergency, dispersancy, corrosion inhibition and pour-point depression.

Literature: Technical Bulletin No. 0-67

SANTOLUBE 395X

Type: Antioxidant and bearing-corrosion inhibitor.

Typical Properties:

Specific Gravity at 60°/60° F.	1.01
Viscosity S.U.S. at 210° F.	75
Color ASTM (diluted)	4
% Phosphorus	3.8
% Sulfur	10.5
% Barium	1.1

Applications: Recommended for compounding premium-type motor oils.

Literature: Technical Bulletin No. 0-56.

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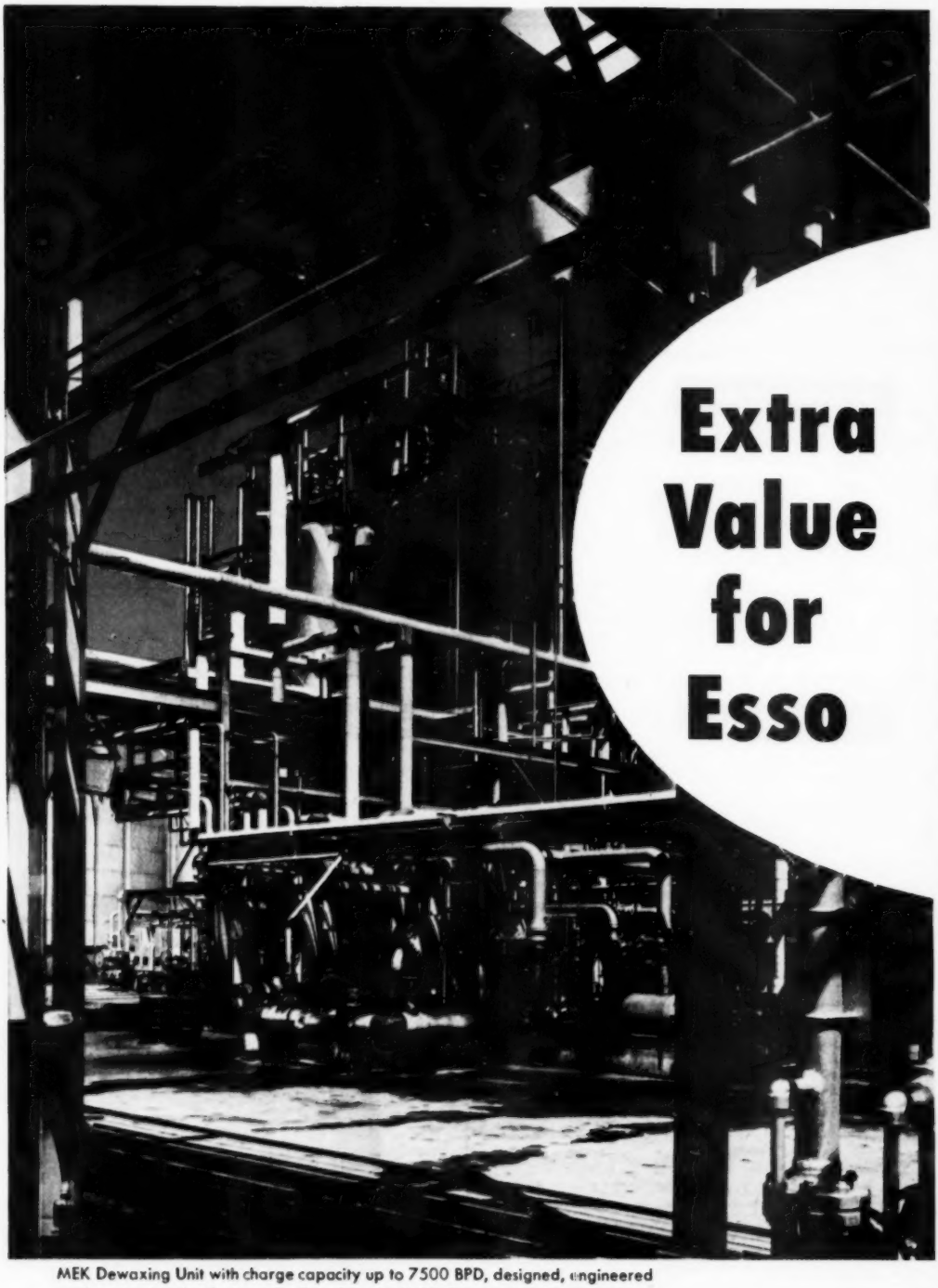
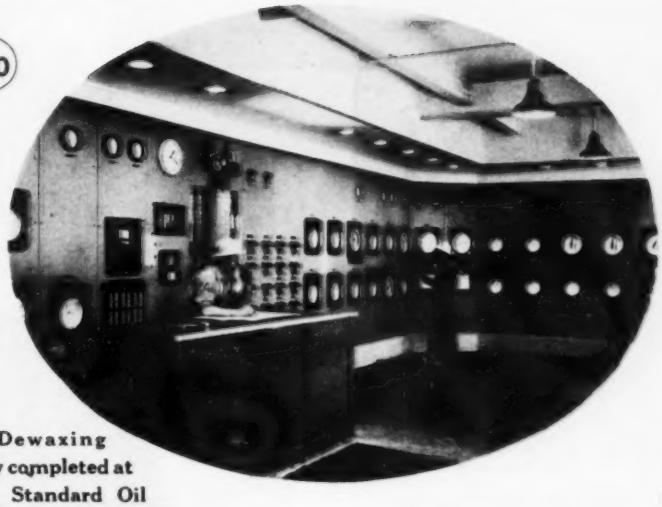


MEK Dewaxing Unit with charge capacity up to 7500 BPD, designed, engineered and constructed by Badger for Esso Standard Oil Company at Bayonne, N. J. Process licensed by Texaco Development Corporation.



This MEK Dewaxing Unit, recently completed at Bayonne, N. J., for Esso Standard Oil Company, is the largest and newest of three such units which Badger has recently designed and constructed for Esso and an affiliated company. Improvements and modifications in each successive unit have provided extra values for Esso, in lower initial cost, earlier completion, more economic operation and easier maintenance.

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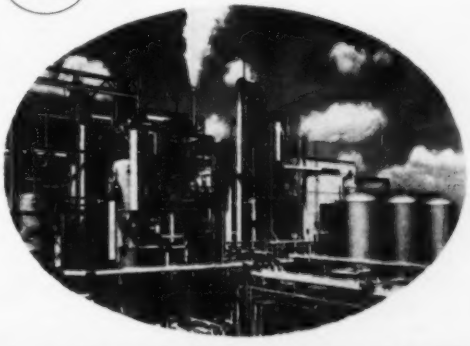

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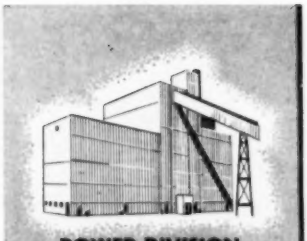

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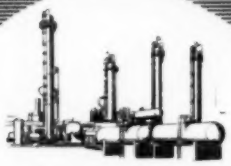

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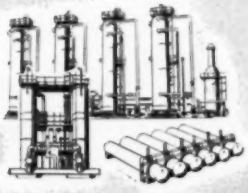

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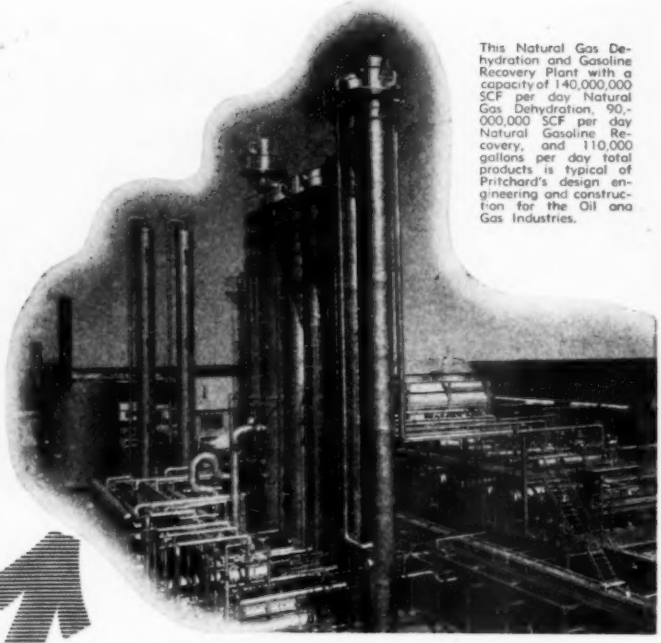

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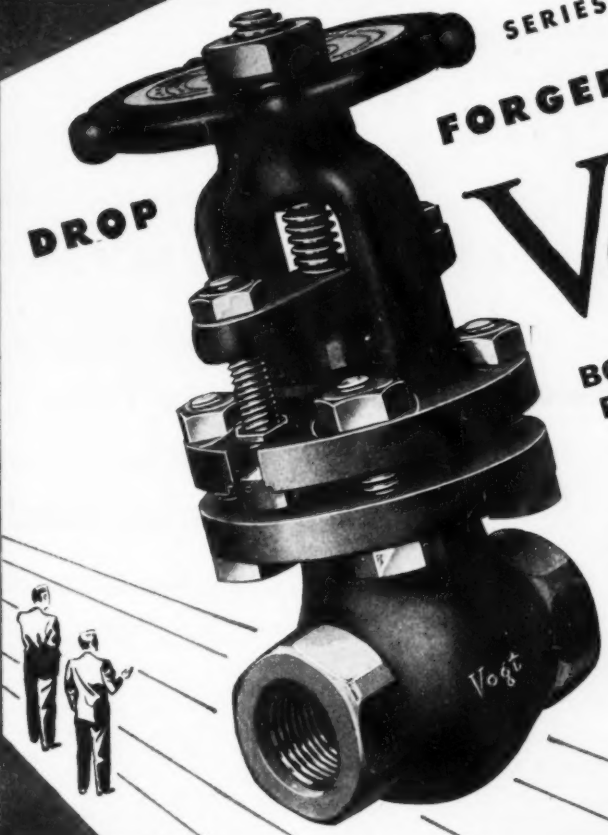

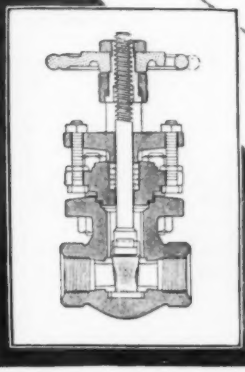

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Conduit-type, double-seating disc in this new Crane valve has circular openings that coincide with seat openings. Flow resistance is reduced to a minimum. There are no pockets to accumulate dirt or contaminating fluids. Turbulence and erosion of seating surfaces are avoided.

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This close-up clearly shows the ribs or corrugations which add strength to Childers Jacketing and also make it form more easily around lines. Aluminum strapping and seals are a quick, inexpensive way to attach the jacketing. They can be used without any special tools and take no special training for the installers.

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AT LAST an aluminum jacket has been "engineered" especially to protect outdoor lines in refineries and chemical plants. It is the first "permanent-type" jacketing that offers both low initial cost and low application cost.

After two years of tests and major installations at 431 outdoor locations in refineries, power plants, and chemical plants, the Childers Manufacturing Co. of Houston has rung up an impressive cost-cutting record with their Childers Aluminum Jacketing.

Secret behind this low cost is the thin aluminum sheet—.006" thick—which is the weather-protecting sheath of the jacketing. It is ribbed (as pictures show) for extra strength and to facilitate forming around the line. This aluminum has proved thick enough to resist weathering and usual abrasion, but costs much less than heavier aluminum sheets.

Easy application of this Childers Jacketing cuts labor bills drastically. It comes from the factory in easy-to-handle rolls that are four feet wide and either 100 feet or 200 feet long. It is light and flexible to handle as the men put it on the line. No roll forming required as with heavy, un-crimped material. It can be cut off and attached just the same as the old-fashioned tar-paper that was sometimes used for jacketing.

You can attach Childers Jacketing around your insulated lines by one of several easy methods. The use of aluminum strapping and seals is probably the best. Sheet metal screws or Minnesota Mining's No. 471 tape can also be used. The Childers jacketing can be removed and re-used.

A moisture barrier is attached to the back of the jacketing to give positive protection for the aluminum when it is used with alkaline insulating materials.

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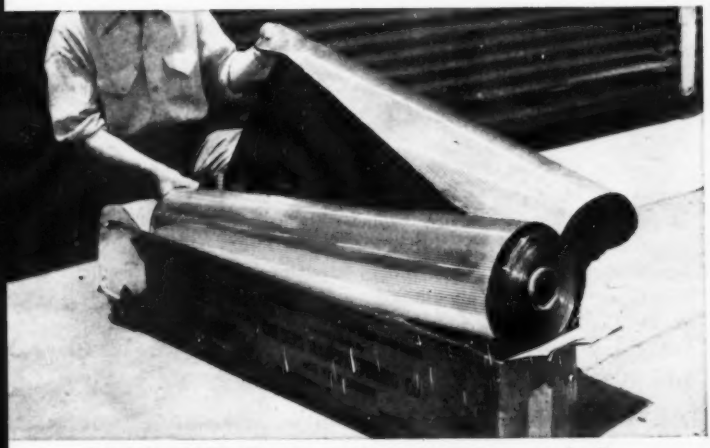

This is how Childers Aluminum Jacketing is shipped in easy-to-handle rolls. It is quite flexible, yet stands up under severe weathering.

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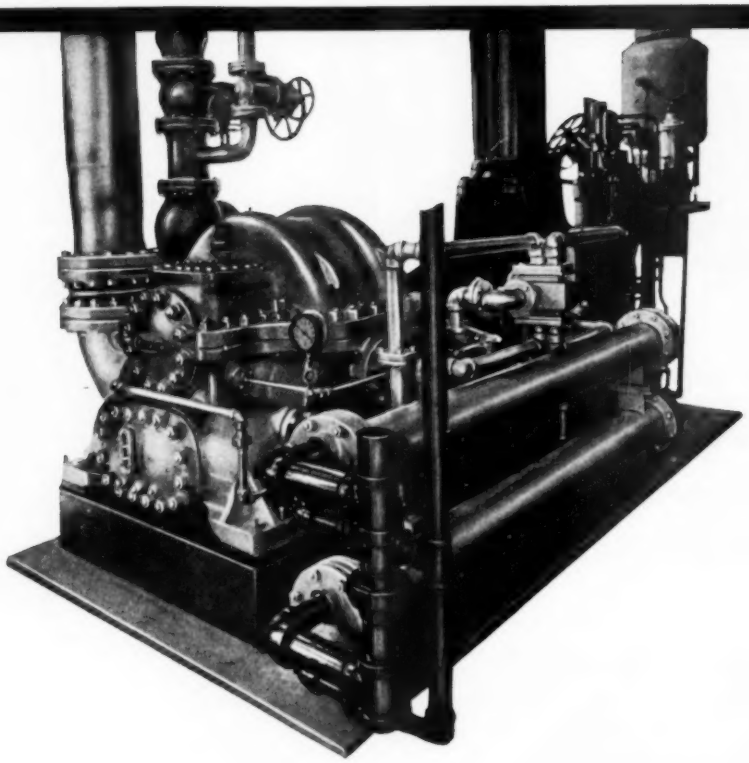
Carrier Compressor supplies process air for The Texas Company



At the Port Neches Asphalt Plant of The Texas Company, this Carrier Centrifugal Compressor is responsible for the supply of process air. It is driven by a direct-connected condensing steam turbine. It is designed for continuous operation.

The turbine and compressor have a common lubricating system; the turbine oil pump furnishes lubricating oil for the compressor bearings as well as its own. Because twin external oil coolers were installed, the compressor can be operated even when one cooler is being cleaned.

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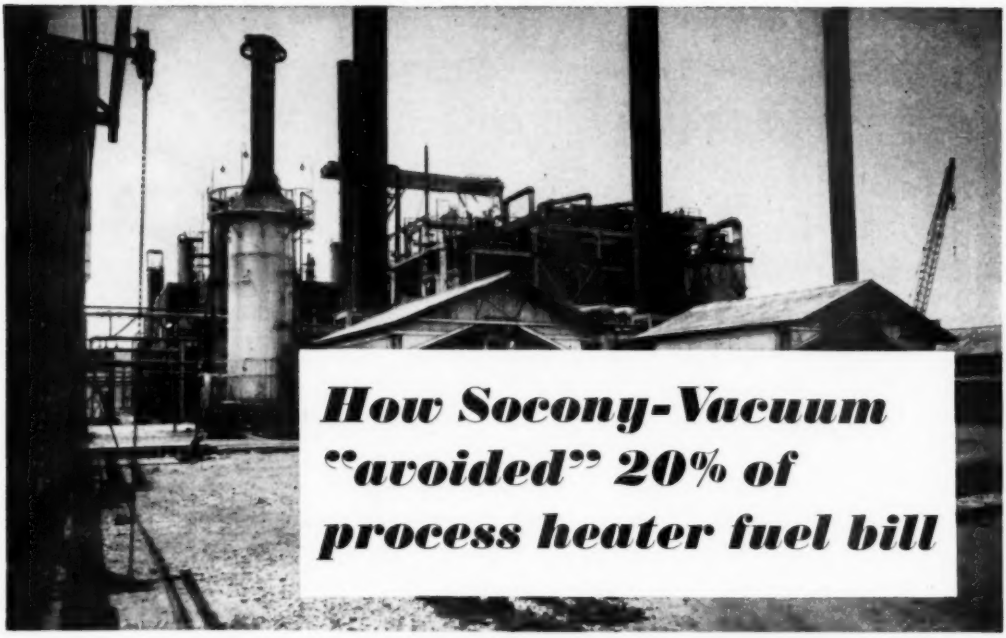

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program →

When engineers at Socony-Vacuum, Trenton, Michigan refinery developed a complete fuel conservation program, process heaters came under close scrutiny. Socony-Vacuum engineers felt they could reduce the total cost of fuel used in raising the temperature of petroleum stock if they could keep the amount of excess air in the flue gases at a minimum.

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Socony's instrument engineers wanted an instrument which would indicate excess air, so that they could make adjustments to keep the air at a minimum and thus save fuel.

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must provide a **continuous indication** so that changes could be spotted immediately.

must **not be affected by changes in fuel composition** since different fuels are used in the heater furnaces.

must not **be affected by the presence of Hydrogen** in the gas sample.

preferably, measurement should have **direct relationship to excess air.**

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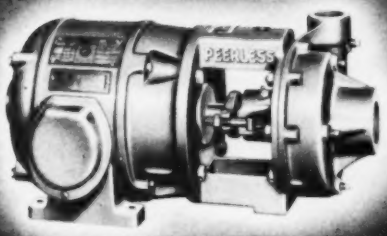
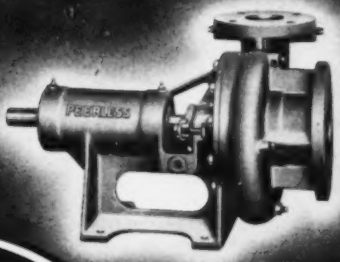


Type PE MOTOR SIZE: 1-60 H.P.
CAPACITY: Up to 1000 gpm
HEADS: Up to 200 Feet

BELTED OR DIRECT-CONNECTED
TYPE *Integral H.P.*



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A COMPLETE LINE OF CLOSE-COUPLED ELECTRIC, BELTED OR FLEXIBLE COUPLED PUMPS FOR GENERAL PURPOSE REFINERY USE

Want compactness? Want efficiency? Want durability? Want economy? You can have them all by using pumps in the versatile and complete line of Peerless Fluidyne pumps.

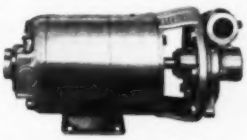
Versatile, because they can be applied to a host of diversified services calling for transferring of liquids.

Complete, because they offer widest range of sizes and models. The Type PE Fluidyne pump, a close-coupled bracket-type pump, is electric drive, available from ¼ to 60 hp. It is close-coupled to standard horizontal pump electric motors. The Type PB is available in sizes up to 150 hp. It differs from the Type PE in that it is built to receive standard V—or flat belt pulleys for engine drive, or it can be mounted on a common base with an electric motor and driven by a flexible coupling.

Both Type PE and Type PB Fluidyne pumps are single stage, end suction, centrifugal design. Simplicity and quality and ruggedness are inherent in their design. All parts are easily accessible. Close attention to hydraulic characteristics has resulted in pumping units of high efficiency, regardless of position in which they are installed —vertical, horizontal, or intermediate angle. Disassembly and assembly for inspection or maintenance is rapid.

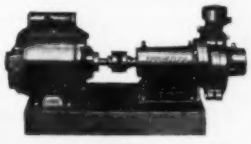
NEW BULLETIN
describes additional features of both fractional and integral hp pumps in the Peerless Fluidyne Line. Write for your copy of this 24-page fully illustrated and descriptive bulletin today.

FRACTIONAL HORSEPOWER CLOSE-COUPLED TYPE PE



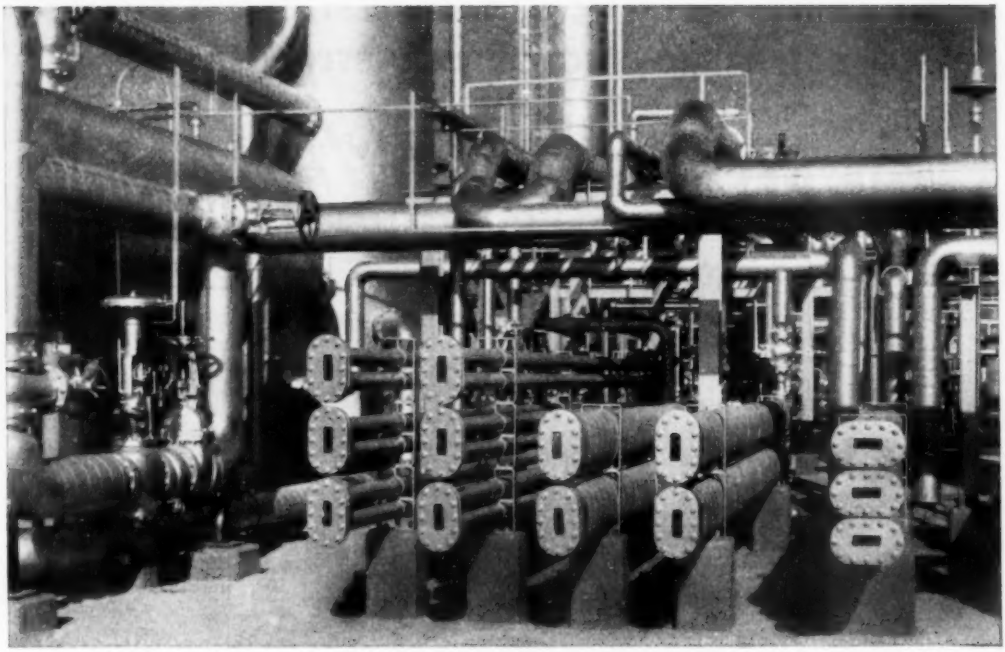
¼ to 1½ h.p. • 3450 rpm • 60 cycle
Capacity: To 65 gpm • Heads: To 110 Ft.

FRACTIONAL HORSEPOWER TYPE PB MOUNTED ON COMMON BASE



¼ to 1 h.p. • 3450 rpm • 60 cycle
Capacity: To 30 gpm • Heads: To 90 Ft.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Address Inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Atlanta, Fresno, Los Angeles, Chicago, St. Louis, Phoenix; Dallas, Plainview and Lubbock, Texas; Albuquerque, New Mexico



use **BROWN FINTUBE**

Sectional Hairpin

HEAT EXCHANGERS *as*

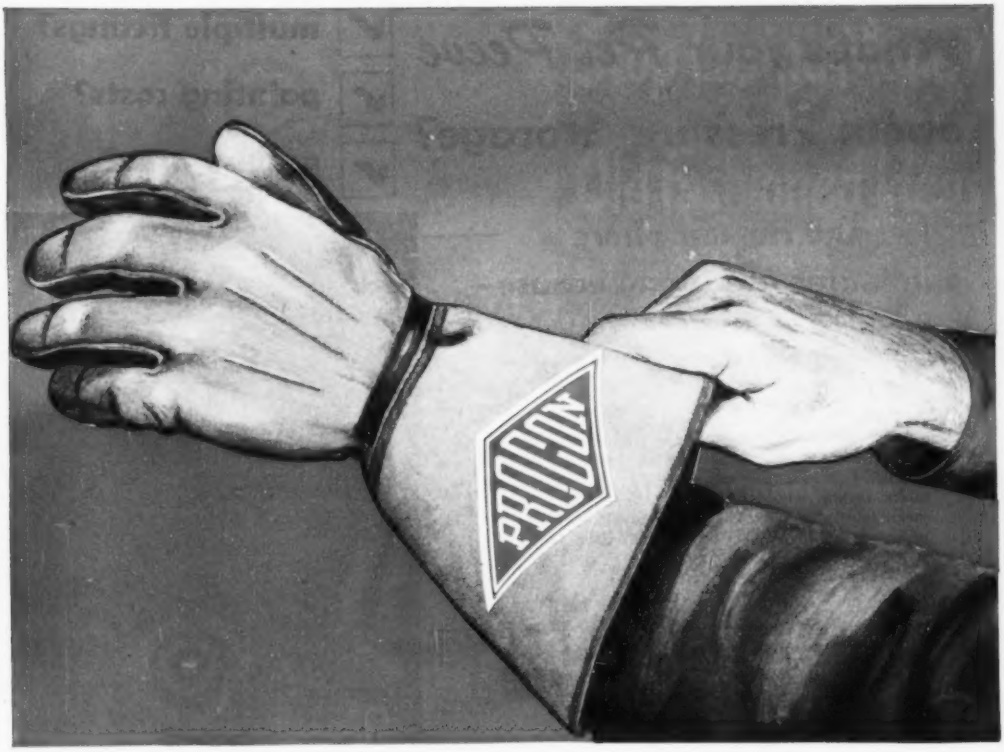
- HEATERS
- COOLERS
- HEAT EXCHANGERS
- CONDENSERS
- GAS COOLERS
- REBOILERS
- FUEL OIL HEATERS
- LUBE OIL HEATERS AND COOLERS
- JACKET WATER COOLERS
- QUENCH OIL COOLERS
- COMPRESSOR INNER AND AFTER COOLERS

● These exchangers combine the repeatedly demonstrated advantages of Brown's exclusive integral "one-piece" fintubes that assure high heat transfer efficiency; and Brown's ring joint head end seal that is easily dissembled for cleaning, and reassembles tightly, preventing leakage. Furnished with fintubes of mild steel, stainless steel, monel, inconel, aluminum, admiralty or other non-ferrous metals to suit any requirement. Widely used — and highly endorsed by engineers, operators and maintenance men everywhere.

Write for Bulletin No. 481. It gives full details.

THE BROWN FINTUBE CO.
ELYRIA, OHIO

SECTIONAL HAIRPIN HEAT EXCHANGERS



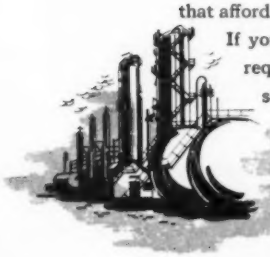
NEW GLOVES FOR EXPERIENCED HANDS

Experienced hands are basic for any efficient construction service. That is why Procon built an organization of individuals with a thorough and complete knowledge of refinery processing facilities and their installation.

From top to bottom... in all important posts at Procon, you will find men who have spent years in this type of work... men who worked together under a single banner and who are thoroughly schooled in all phases of refinery process operations.

So, these experienced hands in new gloves offer the industry an opportunity to acquire a construction service that reaches beyond the usual concepts. A service that affords the ultimate in efficiency and invested-dollar value.

If your plans call for refinery construction work, we will be glad to discuss requirements in view of giving you the benefits provided through Procon service.



PROCON *Incorporated*

PROCESS CONSTRUCTION

75 EAST JACKSON BLVD., CHICAGO 4, ILLINOIS

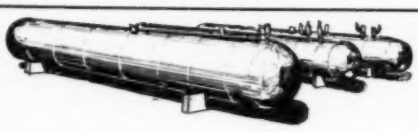
What's your *Pet Peeve* about Pressure* Storage?

- ✔ multiple fittings?
- ✔ painting costs?
- ✔ ground area?

the Hortonsphere eliminates all three because—

1. It has only one set of pipe connections and fittings

The Hortonsphere stores a large volume in a single unit with only one set of pipe connections and fittings. To store the same volume in cylindrical tanks, several would have to be used. That would mean multiple pipe connections and the duplication of some tank fittings. Thus the cylindrical tanks involve costly manifolding and more inspection and maintenance.



2. The Hortonsphere has less surface area per barrel of capacity

A 30-ft. diam. Hortonsphere has *2,827* sq. ft. of surface area and a volume of 2,518 U. S. bbls. For the same volume, you could use three horizontal tanks, each 9 ft. round by 77 ft. long—but the surface area of these tanks would be *6,540* sq. ft.! Since the Hortonsphere has less surface area, it costs less to paint and to insulate.

3. The Hortonsphere also requires less ground area

The figures at the right show how a Hortonsphere requires less ground area. This is an important consideration where land values are high and space is at a premium.

**Pressure storage refers to the type of storage used for light hydrocarbons like natural gasoline and butane. These materials are so volatile that they require a pressure in the vapor space of a storage tank.*

Comparative Ground Area

Hortonsphere— A 30-ft. diam. Hortonsphere has a capacity of 2,518 U. S. bbls. and requires a foundation that covers *1,250* sq. ft. of ground area.

Horizontal tanks—To get the same capacity, you would need three tanks 9 ft. in diam. by 77 ft. long whose foundations would cover *3,080* sq. ft.

These figures deal only with ground area for foundations. To get the ***total*** *ground area needed, you would have to allow for spacing from property lines and other structures. This spacing is usually different for each installation.*

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Salt Lake City 4	530 West 17th South Street
Birmingham 1	1527 North Fiftieth Street	Houston 2	2130 National Standard Building	San Francisco 4	1559—200 Bush Street
Boston 10	1029—201 Devonshire Street	Los Angeles 17	1526 General Petroleum Building	Seattle 1	1330 Henry Building
Chicago 4	2114 McCormick Building	New York 6	3310—165 Broadway Building	Tulsa 3	1620 Hunt Building
Cleveland 15	2215 Guildhall Building	Philadelphia 3	1630—1700 Walnut St. Building	Washington 6, D. C.	Cafritz Building

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Compagnia Tecnica Industrie Petroli, Rome, Italy
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Stop Losing Money with Old Fashioned Ideas

USE GAULIN Two Stage HOMOGENIZERS For Lubricating Oils and Greases

You can increase production, reduce costs and at the same time improve the quality of your products by using Gaulin Homogenizers for processes involving dispersions and emulsions requiring uniform size of 1 micron or less.

These heavy-duty, high pressure homogenizers *give you more capacity* and *use less HP* in the dispersion of additives in lubricating oils. They also cut costs in the production of soap type greases and new benton greases.

They are available in any capacity from 75 to 4000 gallons per hour with operating pressures up to 15,000 lbs. per sq. in.

Their rugged construction throughout assures long operating life with little if any maintenance. For example, the cylinder and all fittings with which the product comes in contact are of 302 or 316 stainless steel. Special spring-loaded design plunger packing insures maximum life and trouble-free operation. Special applications requiring specific metals and types of packing can be constructed to meet individual requirements. Valves and seats are made of either 302, 316 stainless steel, stellite or Hasteloy.

It will pay you to investigate Gaulin Homogenizers and High Pressure Pumps for your processes. Write for complete information and catalog.

Let's talk it over at the INTERNATIONAL INDUSTRIAL EXPOSITION
Booths 226-228
MARCH 11-17 HOUSTON, TEXAS

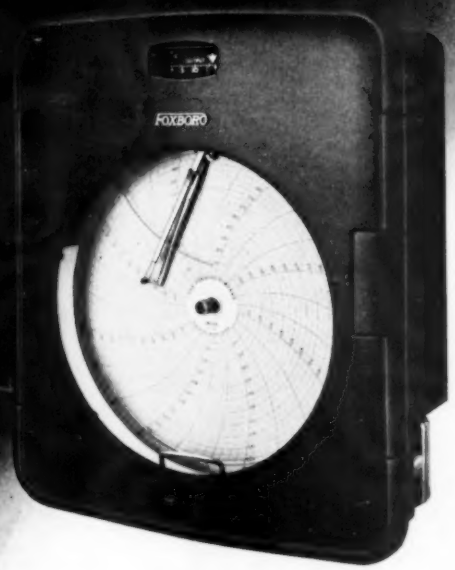
Gaulin TRADE MARK

MANTON GAULIN *Manufacturing* COMPANY, INC.
62 GARDEN STREET, EVERETT 49, MASS.

(To obtain more data on advertised products see page 312)

better measurement and control of

FLOW



Wherever highest accuracy and complete reliability in flow measurement and control are vital to successful processing, it is significant that Foxboro Instrumentation is preferred. Whether your problem involves gas, steam, or liquids . . . in pipes, ducts, or open channels . . . the premium quality and complete diversity of Foxboro Instruments, backed by unequaled application experience, assure you an extra measure of satisfaction.

indicators • recorders • controllers • integrators transmission systems • controlled valves • orifices venturis • nozzles • pitot tubes

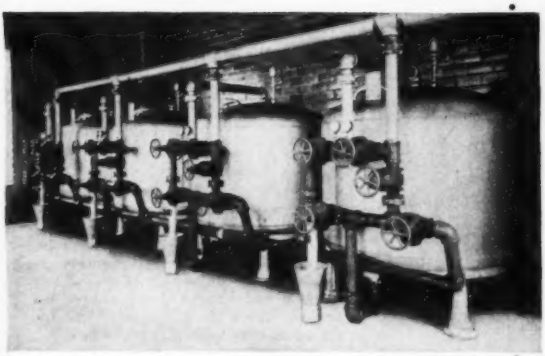
FOXBORO
Reg. U. S. Pat. Off.

For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY • FOXBORO, MASSACHUSETTS, U.S.A.

A GRAVER FILTER

makes the difference



Does your water supply contain sediment . . . silt . . . organic matter or other suspended solids, fine or coarse? Is it ever cloudy or colored?

If so, Graver has the remedy . . . not just a single design of filter offered for any and every clarifying need, but a complete range of filters to include exactly the right unit for each kind and amount of suspended matter.

Graver Filters include pressure and gravity types; sand and gravel, Anthrafilt, and diatomite filtering media; and special designs for removal of iron, oil, taste and odor. Moreover, Graver Filters can be arranged to correct certain other water conditions, such as low pH; and can be combined with other Graver apparatus for additional water conditioning, such as removal of hardness.

Many thousands of Graver Filters are installed all over the country, in plants of every industry, and serving every filtering need.

Whatever may be your water conditioning needs, you can depend on Graver's 40 years of experience and Graver's modern, efficient designs. Your request for advice and specific recommendations will not involve the slightest obligation.

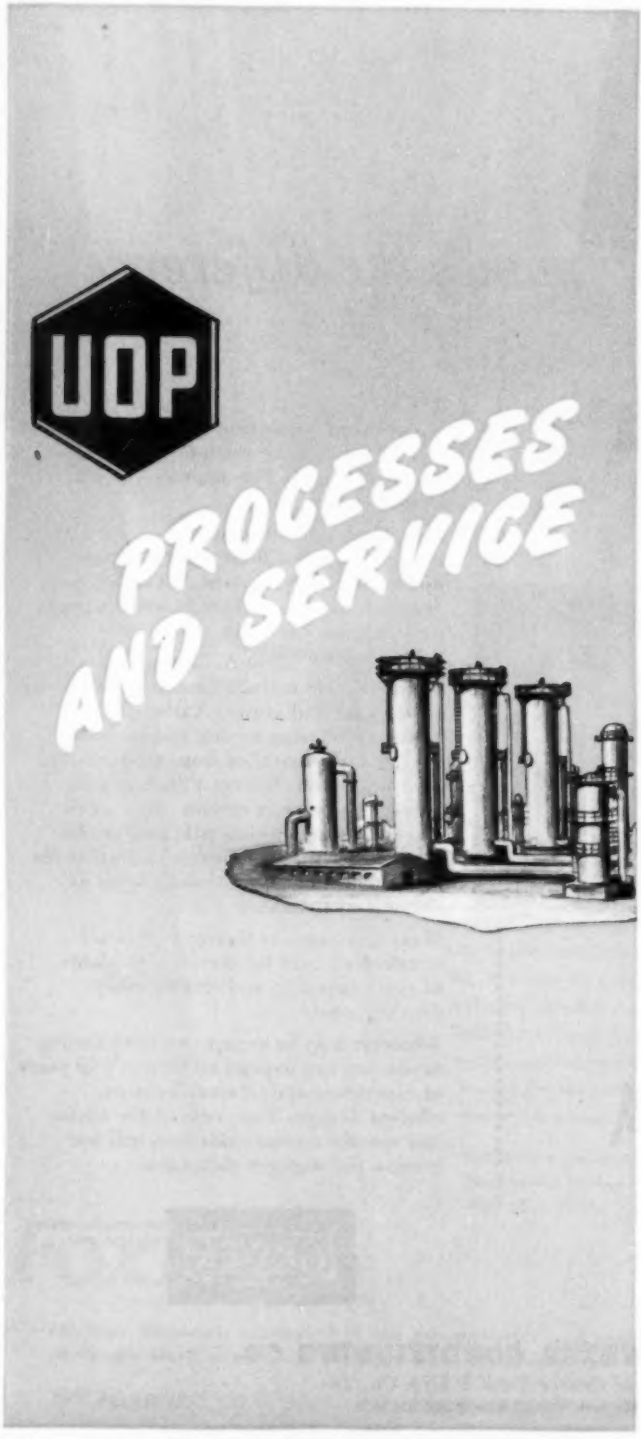
GRAVER

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

216 WEST 14th STREET, NEW YORK 11, N. Y.

GW-482



Platforming Unit to Upgrade Kendall Straight Run—Add Facilities for Defense

By Howard V. Smith,
Refinery Superintendent
Kendall Refining Company

Our decision to install a 1500 barrel Platforming unit was made in recognition of the constantly upward trend of gasoline octane ratings for the knockless operation of increasingly higher compression motors. However, from the beginning possibilities inherent in this type of plant for the production of petro-chemicals were thoroughly explored and excess capacity was incorporated in the design so that modification could be made at a later date for that purpose.

Howard V. Smith

Competitive Situation Called for Higher Octane

A survey of gasoline quality in the nearby Pittsburgh area revealed the following average octane ratings for house brand and premium motor fuels:

	Research Method	*Motor Method*
House Brand	86.2	80.2
Premium	91.8	83.1

Bradford Grade Penna. crude, to which Kendall, being one of the largest producers of 100% Pennsylvania grade lubricating oils, is committed, contains a relatively high proportion of low octane gasoline and naptha which cannot be brought up to the above standards by the addition of tetraethyl lead alone.

This crude runs about 40% gasoline and naphtha, boiling up to 400°F. end point. Sulphur content is low and the combined product has excellent volatility. The research octane number is 50 clear and 70 with 3cc's TEL. Twenty-three per cent of the crude oil is available for cracking in the Dubbs continuous coking plant which yields 77 per cent of cracked gasoline and polymer on the charge. Thermal reforming of straight run naptha is included in the Dubbs plant operation.

All Processes Explored

Our engineers made a thorough study of available processes before reaching a decision that Platforming offered the most economical solution to our problem. Engineering studies showed that thermal reforming to the extent considered economical would still leave the anti-knock quality of the product short of the ultimate goal.

Pilot plant studies in the Universal Oil Products Company's laboratories demonstrated that the Platforming process would convert the 400 end point full boiling

 (To obtain more data on advertised products see page 312)

range gasoline into 95 octane gasoline with 3cc's TEL, with a yield of more than 90 per cent by volume. Details of this pilot run are expressed in the following table:

Inspection of Kendall Straight Run, Fractionated Reactor Charge and Stabilized Platformate

	Full Boiling Range Straight Run Gasoline	*Reactor Charge*	*Platformate*
API Gravity	64.9	58.0	58.2
IBP	90	180	102
5%	117	201	134
10%	136	211	150
30%	198	235	188
50%	243	264	225
70%	290	306	262
90%	358	360	327
95%	381	377	364
EP	394	399	411
RVP	10.3	0.7	9.5
Octane Ratings			
F-1 Clear	50.1	40.2	84.1
F-1 3cc's TEL	69.7	61.2	95.3
F-2 Clear	49.5	38.0	78.8
F-2 3cc's TEL	69.5	60.8	87.9

Consideration of Defense Requirements

Another consideration was the fact that in the event of a drastic shift in requirements due to the impact of a defense or war economy on the nation, our Platforming facilities could be converted to the production of aromatics, aviation gasoline components, benzene, toluene and other petro-chemicals which might be needed for military purposes. While this conversion would require certain modifications in the unit itself, as well as additional feed stocks from outside sources, the change-over would not radically disrupt our operations and full utilization of the new unit would be possible.

Special Design Features

The plant design for our Platforming unit, incorporates some special features, particularly applicable to our circumstances. Since our charging stock is well fractionated and free from heavy ends, it was decided that a suitable reactor charge stock could be prepared from it by distilling off the light ends in a dependanizer. Utilization of this method instead of a prefractionator, reduced size of the equipment as well as the operating cost.

Air contamination of the charge stock will be minimized by blanketing the charge tanks with dry gas from the vapor recovery unit of the refinery. The dependanizer overhead will be depropanized to produce a blending stock for volatility control. Depropanizer overhead will be charged to the Platformer stabilizer to reduce butane loss. Recycle gas and reactor charge will be mixed before entering the heater and heated as one stream instead of separately.

Our new Platforming unit was designed by Universal Oil Products Company in collaboration with our engineering department. It is being erected by Procon Incorporated, and is expected to go on stream in March of 1951.

(To obtain more data on advertised products see page 312)

SET THE STAGE NOW FOR 1952
PRESENTING YOUR NEW REFINERY . . .
WE ARE THE ORIGINATORS OF THE "NEW LOOK" IN REFINERIES, WITH "PICTURE WINDOWS" TO MAKE THE PUBLIC CONSCIOUS OF YOUR PROGRESSIVENESS.

You remember how fast 1950 passed. 1951 will seem to pass even more quickly and by 1952 you will wish your refinery were modernized or that you had an entirely new plant.

You can have that new cat cracker or new refinery if you plan now, and place your problem in our hands. We have the ability, manpower and equipment to design, engineer and construct the refining facilities you need in the least possible time.

Call, wire or write for a discussion of your refining problems and their solution, without obligation. Our airplanes make us neighbors.

TRECo

REFINERY ENGINEERING *Company*

PHONE 5-5561 • TULSA, OKLAHOMA

PETROLEUM CHEMICALS DIVISION

NEWS

March ★ One of a Series of Interest to the Petroleum Industry ★ 1951

Additional Facilities For Petroleum Laboratory Nearing Completion

The Du Pont Petroleum Laboratory, devoted to fundamental research and technical development on chemical additives for fuels and lubricants, will soon increase its laboratory facilities by approximately 50%. Work on the expanded facilities started about a year and a half ago. Some units are now in operation and it is expected all will be functioning by late spring.

The expansion, located principally in a new building, will add considerably to the laboratory floor space and will permit greatly increased activity in the petroleum chemicals research program which originated about three years ago.

Tel Tank Car Unloading Simplified by Du Pont-Designed Metal-Flex Hose Line

Conventional pipe lines with swing joints for loading and unloading TEL tank cars have never been completely satisfactory. Keeping the joints properly packed so as to prevent the escape of dangerous tetraethyl lead or "lead" fumes always presented a safety and maintenance problem. Repacking such joints frequently tied up three or four pipefitters for an entire day.

Even when properly maintained, there was no assurance that joints would be tight and unloading difficulties were often encountered due to leaks. Swing joints that did not leak were usually so tightly fitted that the operators had difficulty in manipulating them into position. This cost both time and effort.

Du Pont recognized the cost and hazards associated with the maintenance of such lines and designed a metal-flex hose which eliminates swing joints altogether.

Complete flexibility of this hose is obtained through the use of a flexible metal tube which is strengthened by braided wire mesh to withstand pressures up to 100 lbs. per sq. in.

Customers report the following advantages:

1. Greater ease in connecting up the tank car. Only one man required where, with the old style, two men were frequently needed.
2. Freedom from leaks which cause unloading difficulties.
3. Complete elimination of expense and hazards connected with repacking the old type swing joint.

Du Pont standard drawings and specifications now include the flexible type hose as standard equipment. The operation of replacing the old type line and swing joints with metal-flex hose is simple and inexpensive. The Company can make the hose available through its Petroleum Chemicals Division District Offices and is happy to furnish the necessary engineering service.

Success of National Tour of Du Pont Road Octane Fuel Test Fleet in 1950 Leads to Expansion of Activity for '51

Back in May 1950, Du Pont began a new kind of experiment. It originated around three highly instrumented automobiles. These were designed to show that road octane tests could be conducted with a neatness and dispatch hitherto not often practiced in the petroleum field.

Test cars Nos. 29, 30 and 31 shined up for the 1950 cross-country tour. Du Pont men in the foreground are Harold Russell, Carl Ferris and Ray Spender discussing the route to be taken to the next day's demonstration.

In the course of a few months the cars toured the country from coast to coast giving test demonstrations to refinery personnel everywhere. At the end of their trek each of the cars, an Oldsmobile, a Plymouth and a Chevrolet, had covered some 23,000 miles.

Out of 236 petroleum company headquarters and division offices contacted before and during the tour, 233 indicated an interest in the project and requested that presentations or demonstrations be made to their personnel. The showings varied from private viewings of the cars in big-city hotels including formal talks or round-table discussions, to road demonstrations at refineries situated many miles away from the nearest town.

There was nothing new in the actual instrumentation of the demonstration cars. But the convenient way Du Pont engineers arranged it on the dashboard, and especially the ease achieved in changing from one fuel to another by the simple manipulation of push buttons, showed that road octane testing did not necessarily have to be the somewhat crudely conducted chore so many had thought it to be.

And that is what appealed especially to most of the 3,144 petroleum men who saw these cars in 1950. It is also the reason for the augmented fleet planned in 1951.

OVER

ADVERTISEMENT — Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

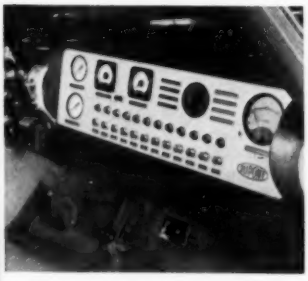
CONTINUED

Fleet Tour

The three original cross-country cars have been torn down, examined, checked, reassembled and restored to perfect running order. Two were subsequently sent to Florida on a brief tour along the Plantation Pipe-line. The third was driven to the Chicago territory where it is being used by various petroleum companies as an aid in dealer training.

Soon four more cars will be added to the fleet. These will be the latest models of Packard, Buick, Ford and another Oldsmobile. They will be instrumented in much the same way as the three original cars.

But the seven road test cars, this time, will not go on tour. Instead one, or two, will be assigned to each of the five Du Pont Petroleum Chemicals District Offices where they will be made available to refiners, laboratories or marketing groups for educational or demonstration purposes.



The instrument panel of the test cars is designed to blend with the original dashboard. The push buttons for venting, for tank fuel, and for reference and test fuels are in line on the lower part of the panel. Red warning lights indicate the fuel being used.

For those organizations who desire to build similarly instrumented road octane test cars of their own the Du Pont Company will be happy to supply specifications and photographs. The Company will also give, wherever possible, such personal technical assistance as may be needed to place the cars in operation.

With the advent of the new cars, Nos. 39 to 42, this will bring to forty-two the number of cars and trucks that have operated in the Du Pont Petroleum Chemicals Division test fleets. Of this number twenty-eight are in active operation today.

Aviation Specialist on Staff of Petroleum Chemicals Division

JOHN R. GRIFFIN, JR. joined the technical staff of the Du Pont Petroleum Chemicals Division in July 1950, and now specializes in fuel and lubrication problems connected with aviation. He holds a Master's degree in engineering.

After a year of teaching at the University of Texas, he joined the Lockheed Aircraft Company where he engaged in the structural testing of planes including many of the tests which prepared the now famous P-38 for flight. In 1941 he joined the Shell Development Company to work on lube oil development for 2½ years. From 1943 to 1949 he was with Trans World Airlines handling maintenance problems. During his last four years with TWA he was in charge of engineering for over-ocean operations at New Castle Airport, Delaware. He came to Du Pont from the Sharples Corporation where he was chief engineer in the research laboratory.

At present, Griffin spends most of his time conferring with airlines regarding present and future developments of the various types of aircraft propulsion units and fuel requirements for these units.

Du Pont Spray Glaze

New Car Polishing Product Saves Time and Labor

Attractive new SPRAY GLAZE container belongs to famous Du Pont No. 7 Line of products.

SPRAY GLAZE, a new protective coating and polish for automobile finishes was brought out by Du Pont in 1950. Formulated to be applied with a special spray gun, Du Pont SPRAY GLAZE is for use by service stations, car dealers, body shops and fleets. It produces a higher lustre than waxes and requires less time and labor to apply.

After the car finish has been thoroughly cleaned, SPRAY GLAZE is applied by air gun over the entire surface in a matter of a few minutes. Final polishing is easily and quickly done by hand with clean dry cloths. Because of the nature of SPRAY GLAZE, hard rubbing is not necessary.

LITERATURE AVAILABLE

The Petroleum Chemicals Division of Du Pont has published a wide variety of material of interest to the petroleum industry. This includes technical papers, bulletins, reports and memoranda as well as equipment operation bulletins, safety regulations, tank cleaning data, marketing aids and the like.

Any of this is available on request to your nearest Du Pont Petroleum Chemicals Division District Office. A partial listing of available material is shown below:

Tank Talk—A new 52-page booklet designed for easy reading by tank cleaning personnel — Serial A-1134

Blending calculator for Du Pont TEL Compound (Aviation Mix) — Serial A-1210

Exhaust Valve Rotation—A resume covering the use of mechanical devices to improve valve life — Serial A-656

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

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District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

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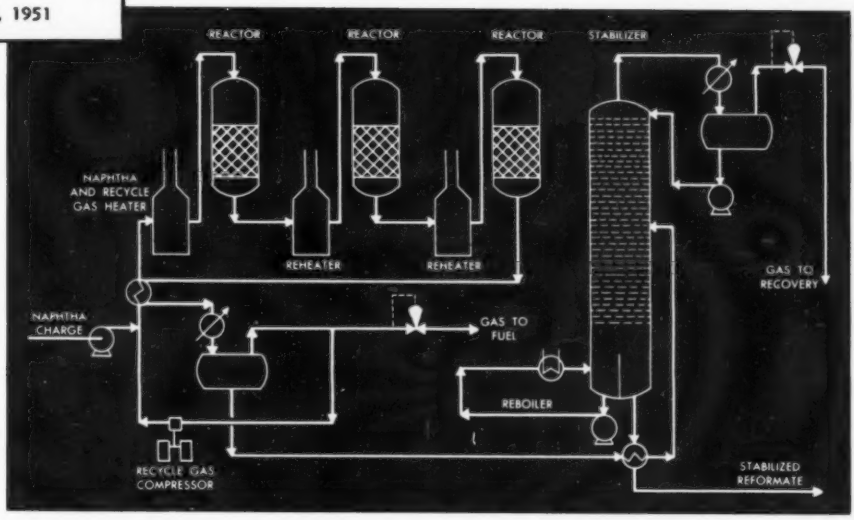
A-1759

Printed in U. S. A.

PETROLEUM PROCESSING

MARCH, 1951



A NEW PLATINUM CATALYST developed by Atlantic Refining Co. is the key to their reforming process, just announced, which gives . . .

39% Benzene Yields

From a C_6 Straight-Run Fraction

A NEW catalytic reforming process using a platinum catalyst has been developed by Atlantic Refining Co. Aside from its use for the conversion of low-octane straight-run naphthas to finished high-octane gasoline, the process is capable of producing substantial amounts of highly concentrated aromatic streams.

Benzene yields of over 39% (vol.-% of fresh feed) have been realized with the process in pilot plant runs charging a C_6 straight-run fraction on once-through operation. Equally high yields of toluene have resulted when charging a C_7 straight-run fraction.

When operating to produce avgas blending stock from a C_8 fraction, the process resulted in a yield of over 27% of aromatics, with a 3-C (plus 4.6 cc. TEL) performance number of 239. Atlantic explains this unusually high rating on the grounds that the aromatic product separated by fractionation is very low in ortho-xylene. The top grade of military avgas has a leaded 3-C rating of 145.

At the same time that Atlantic first disclosed details on its new process last month, it also announced that it is building a new 11,000 b/d commercial unit employing the process at its Philadelphia refinery, and that several other refiners are considering putting up units.

Benzene Not Included in Plans

Atlantic's present plans are to operate the unit for motor gasoline production, and do not include the manufacture of benzene and other aromatics. The possibility of including the necessary feed preparation and product recovery facilities for benzene is being studied, however, according to Hugh W. Field, vice president and general manager of Atlantic's research and development department.

Atlantic estimates that enough feed stock is presently available in its Philadelphia refinery to make 500 b/d of benzene—or over 7,500,000 gals. per year. That output would require operating the unit on benzene production only about 15% of the time. If sufficient feed stocks were made available company engineers believe this

output could be stepped up to 3,000 b/d—or 46,000,000 gals. per year.

Cost of the new 11,000 b/d reformer is estimated at between $4 and $5 million. Construction contracts are expected to be let shortly, and completion is planned for the early part of 1952.

Under Development Since 1946

The new Atlantic process has been under development for the past 4½ years, and the company has been operating a 5 b/d pilot plant at its Philadelphia laboratories since last July.

The process itself is essentially the same as other catalytic reforming processes, in that it involves passing a vaporized feed stock over a fixed bed of catalyst in the presence of recycled hydrogen.

The mechanism of the reaction likewise is similar—isomerization of paraffins to iso-paraffins, and the isomerization and dehydrogenation of naphthenes to aromatics.

Advantages claimed for the Atlantic process are based, it appears, primarily on the nature of the new platinum catalyst that Atlantic has developed. Exactly what the catalyst is and how it works, however, the company has not revealed.

Davison Chemical Corp. is manufacturing the new catalyst commercially at its plant in Baltimore, Md.

One advantage claimed by Atlantic for their catalyst is that it permits operation at relatively high space velocities — in the order of 5.0 wt. space velocity.

Charge stocks to the process may consist of any fraction of crude naphtha up through normal gasoline end point, natural gasolines, and mildly thermally cracked naphthas. No special rerunning facilities for feed preparation are required when operating for motor gasoline production, it is said, since neither sulfur nor normal water concentrations contaminate the catalyst.

Flow Diagram of Process

A schematic flow diagram of the new Atlantic process when operated for motor gasoline is shown above. The charge naphtha and a recycle hydrogen stream are heated together first by exchange and then in a furnace to the operating temperature —in the range of 850 to 1000° F. The mixture is then passed through three reactors in series, with intermediate reheaters between the reactors to compensate for the endothermic heat of reaction.

The final reactor effluent is cooled by exchange with the incoming fresh feed and then with water, and flows to a high-pressure gas separator. Recycle hydrogen, which is consistently above 95% purity, is compressed and returned to the reactors. Separator liquid flows to a conventional fractionating tower for stabilization.

Operating pressure in the system is maintained at the desired level (between 300-700 psi.) by a pressure regulator on the high pressure gas separator, which bleeds excess hydrogen to fuel or other uses. In view of the high purity of the hydrogen normally about 97-98%, Atlantic's research people are now working on possible means of using the excess gas other than for fuel.

Atlantic does not anticipate that the catalyst they have developed will require regeneration under normal operations. When operating at extreme severities of reforming or on charge stocks containing material in the kerosine boiling range, regeneration once every six weeks or so may be necessary to remove small amounts of coke deposited on the catalyst.

Such regeneration can be accomplished without taking the unit offstream. One reactor at a time will be by-passed, purged, blown with dilute air, and put back into service in less than 24 hours. During the regeneration of one reactor the other two will be kept in operation at a somewhat reduced rate of flow. Regeneration will be carried out at the operating pressure of the unit.

About once a year, Atlantic believes, the catalyst will have to be completely replaced with fresh material—the platinum content of the old catalyst being recovered. During that period it is expected that catalyst activity will be reduced to a minimum desirable level—through metal poisoning and gradual deactivation as a function of time.

Yield and Quality Data

Yield and quality data for motor fuel production from East Texas crude naphtha, a typical reformer stock, are presented in Table 1. In addition to the high yields obtained, the reformate is essentially free of sulfur and olefins such that no treating of the finished gasoline is required. Data in this and other tables in this article are based on work done by Atlantic in their reformer pilot plant at Philadelphia.

Data on the production of benzene by once-through operation on a C_6 straight-run fraction are presented in Table 2. Almost 85% conversion of naphthenes is achieved, which indicates that extensive isomerization of C_5 ring compounds has taken place to make this result possible.

Data on the production of toluene by once-through operation on a C_7 fraction from crude naphtha are presented in Table 3. A once-through conversion of about 95% of the cycloparaffins was achieved, again indicating the extent to which isomerization is achieved.

The production of aviation blending stock from an East Texas C_8 cut is presented in Table 4. A substantial yield of high octane blending stock, 27 vol.-% of fresh charge, is achieved.

Atlantic plans to make their process available to other refiners on a royalty basis, and is presently carrying out negotiations with a number of companies who are interested in licensing agreements.

TABLE 1—Motor Gasoline Production—East Texas Naphtha

	Charge	Products I	Products II	Products III
API Gravity	55.9	52.1	51.7	50.7
RVP	1.0	2.6	2.7	3.7
ASTM Dist. 0	188	142	134	122
10	215	194	192	177
50	257	254	250	243
EP	373	382	370	385
CFRR Octane 0 cc	54.5	73.6	79.8	85.0
3 cc	74.3	90.8	93.7	96.3
Yields, % of F.F.				
Vol % C_5 plus		93.5	90.7	88.6
Wt. % H_2		1.37	1.49	1.75
C_1		.07	.10	.19
C_2		.12	.27	.45
C_3		1.18	1.96	2.75
Vol % C_4		2.28	4.27	5.39

TABLE 2—Benzene Production

	Charge Stock	Product
% Paraffins	36.2	32.7
% Cyclopentanes	26.5	6.8
% Cyclohexane	29.6	0.8
% Benzene	7.4	45.8
% Toluene	0.3	4.9
% C_8's	...	2.9
% C_9	...	6.1
Boiling Range (TBP), °F.	160-185	...
Vol. % F.F. (C_6 and heavier)	100	85.5

TABLE 3—Toluene Production

	Volume, % Charge Stock	Product
% Paraffins	35.0	19.0
% Cyclopentanes	26.2	2.1
% Cyclohexanes	28.3	0.8
% Benzene	...	2.4
% Toluene	10.2	46.6
% Other Aromatics	0.3	7.1
% C_8's	...	2.2
% C_9's	...	19.8
Vol % Fresh Feed (C_7 and heavier)	100.0	89.1

TABLE 4—Aviation Blend Stock Production Charging East Texas C_8 Fraction

Total Reformate Yield—Vol. % Chg. 84.1
Aromatic Blend Stock—Vol. % Chg. 27

	Charge Stock	Aromatic Blend Stock
Gravity, API	55.6	33.0
ASTM Dist. 0	246	278
10	250	280
50	255	281
90	263	283
EP	295	316
Octane 1-C @ 4.6 cc TEL		109.7
3-C @ 4.6 cc TEL		239 P.N.

FIG. 1—Pile of salvage yard receipts awaiting sorting and appraisal

GOLD in the Plant Scrap Pile

Wartime Shortages Point Up Value to the Refiner Of an Efficient Materials Salvaging Department

By D. P. THORNTON, Jr.
Southwestern Editor

AN EFFICIENT Salvage Department has functioned at the Pan American Refining Corp.'s Texas City, Texas, refinery practically from the day the plant was put into operation. Its work goes on about the same, in peace days or in time of war. Its full value to the refinery is best recognized, however, in periods of material shortages, whether caused by war or other circumstance.

"Salvage" means to save and the department at Texas City confines its activity to this definition, sorting all discarded materials either into scrap or potentially reclaimable materials. The value of salvage items returned to the plant storehouse via the salvage yard amounts to approximately 10% of the total material the storehouse issues.

An apparent paradox is that, as an operating group, the Salvage Department merely tries to "break even." The only "profit" shown over the cost of sorting and reconditioning is from scrap metal sales. No recondi-

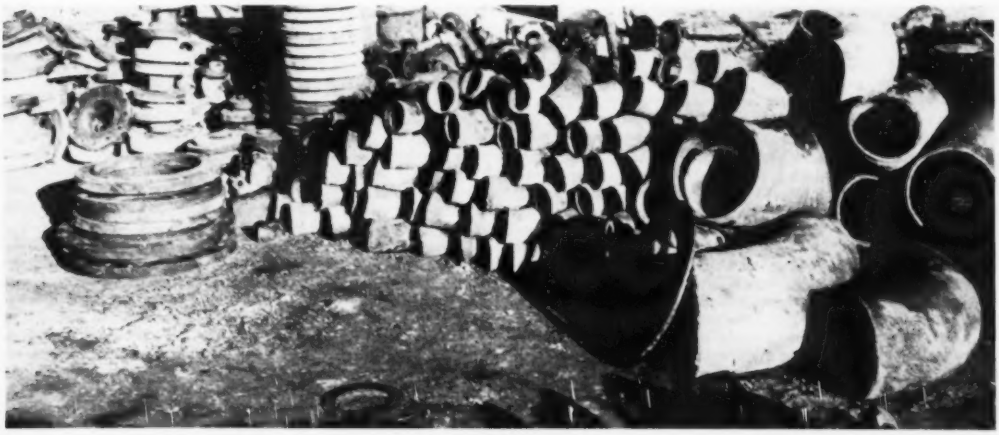


FIG. 2—Orderly stacks of salvaged pipe fittings ready for transfer to the storehouse and re-use

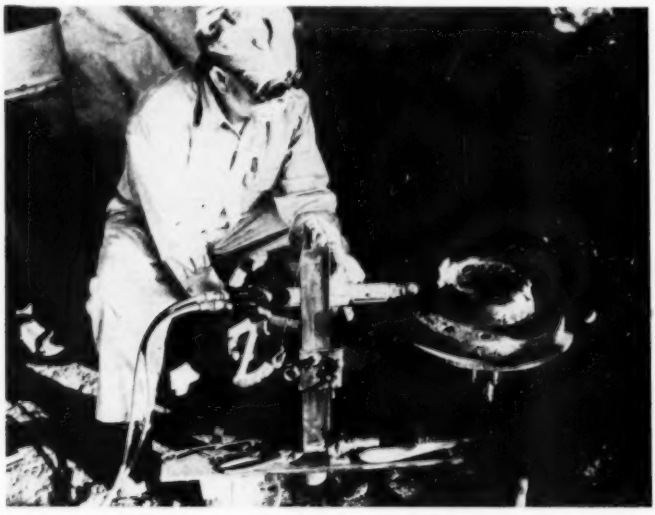


FIG. 3—Jig used for rebeveling welding-neck flanges

tioning work is done except rebeveling welding-neck flanges and repainting repaired items, as the salvage yard is mainly concerned with classification and routing of materials.

The salvage procedure includes a unique accounting system, whereby the plant facility originating salvageable materials is credited with the value of material as received. Subsequently reconditioned items bear the salvage cost and are taken into the storehouse at their repaired value. In the plant organization chart the Salvage Department is a part of the stores division.

Department Make-up

The physical make-up of the department is simple and no skilled labor is permanently assigned to it. It uses two unpaved main yards on either side of a 50-ft. square concrete work area. One yard is for receipts from the plant, and the other for storing reconditioned items until transferred to the storehouse. In the center of the concrete work area is a small one-room building housing a desk, small workbench, tool cabinets and storage for certain small reconditioned items before their delivery to the storehouse.

Equipment consists for the most part of small hand tools; screwdrivers, hammers, pipewrenches, end-wrenches, painting equipment and the like. The only power tools are a combination grinder and buffer plus a hacksaw. An oxy-acetylene cutting torch and steam-heated cleaning vat complete the picture except for several workbenches equipped with heavy vises. No mobile lifting equipment or trucks are permanently assigned to this department, but these are available as needed from the motor pool.

At one side of the salvage area proper lies a much larger area aptly named "The Boneyard." Included at the time of the writer's visit were stacks of retired furnace tubes, pipe fittings, pieces of structural steel, a dismantled feedwater deaerator, several bulk-station tanks on cribbing, discarded tube bundles and lengths of used pipe with salvageable flanges, to name a few things visible. All were items of potential usefulness, such as, for example, several large, fire-damaged I-beams, short lengths of which still are good as new. In the Boneyard also are the scrap files segregated as to iron, brass and copper, waiting for the junk dealer's semi-weekly visit.

The Salvage Department staff consists of a clerk and two men, generally on permanent assignment from the plant labor pool, working on a single day shift. The clerk operates under orders from the storekeeper to assign work and keep records. It is not the practice to assign returnees from industrial accidents to this work, or disabled personnel and older men "just to find a place for them." When specialized help is required personnel from the regular plant crafts are assigned, such as burners, riggers (to move heavy items) and occasionally painters. Loading and unloading service is furnished by delivering company departments or scrap buyers.

All material removed from turnarounds and general maintenance jobs is routed to the salvage yard, where everything either is tallied by estimated weight as scrap, or else by item. Where feasible, individual items are tagged, showing to which tally they are a part. Receipts then are segregated into salvage or scrap. Fig. 1 shows a part of the "as received" pile. The orderly material stacks of Fig. 2 are ready for the storehouse.

Cleaning and appraisal are the next steps. Materials are immersed in a hot detergent bath until reasonably clean, then examined. It may now be decided that an item first considered reconditionable actually is not worth it. Such are scrapped after any useful parts have been removed. Unless obviously useless the item always is assumed salvageable.

Appraisal is by no means precise. In general an article is assigned a "as received" value (expressed as a per cent of "new" cost) which, when added to the reconditioning expense will not exceed 80% of its replacement cost. Otherwise it is valued by estimated weight as scrap. The "as received" value is credited to the unit from which the article was received and the salvage yard debited accordingly, whether scrap or reconditionable. Doubtful articles, generally used pipe are laid aside until enough accumulates to warrant a visit from the inspection department.

Through previous experience the clerk knows the approximate cost of reconditioning various items and makes his appraisal accordingly. For example, small valves costing less than $12 new are scrapped if they require anything beyond simple cleaning, repacking and testing.

This is not a hard-fast rule, however. The mechanical department well recalls the time it dug out several barrels full of small valves which, by luck, the junk man had not yet picked up. These were reconditioned regardless of cost because they were needed to return an operating unit to service, before new valves could be obtained. Naturally, such cases, which happen now and then in every refinery, are neither the normal function nor concern of the salvage yard. Indeed it had quite properly condemned the valves in question as scrap because, under normal circumstances, the repair expense was entirely incompatible with replacement cost.

Following cleaning and appraisal, salvageable items are sorted into like kinds for transfer to the plant mechanical shops. Control instruments, for example, are routed to the instrument shop along with pressure gauges. Welding-neck flanges, requiring more repairs than simple beveling, and valves go to the machine shop. Other items may be relegated to the Boneyard for potential future use, such as used pipe.

The Pan American refinery in general has not felt the need for maintaining a stock of stand-by exchanger tube bundles, as retubing of bundles is performed during regular unit turnarounds. When a bundle goes out of service because of a process change the heads and shells go to the Boneyard if any useful life remains.

Salvaging Pipe and Valves

About 90% of the Salvage Department's work is concerned with pipe, fittings, and valves. After cleaning, these items are broken down into their component parts. Small pipe fittings are returned to stock after cleaning. Welded flanges are burned off freehand, even though the pipe itself also is in useful condition. Later these are put in a jig and rebeveled, and then are transferred to the storehouse. It is not considered practical to leave one flange on a useable piece of pipe, although there are some points in its favor. In practice, however, it was found that the remaining flange is nearly always the wrong type when it comes to reusing the pipe, so it is burned off.

The home-made flange rebeveling jig in use, shown in Fig. 3, was made from salvaged materials. The bottom support is a piece of boiler plate welded to a welding-neck flange to form a pedestal. The revolving table which holds the work, grooved with concentric circles to aid accurate positioning, also is boiler plate. The rotating mechanism, hand-powered, was once the bonnet of a gear-operated valve and the old stem now is the axle for the revolving table. The adjustable support for the burning torch was a discard from an automatic machine in the welding shop.

The operator centers the flange on the revolving table, then positions his cutting torch to give the desired bevel, allowing for the fact the neck was cut from the pipe freehand. Cutting itself is conventional practice, the table being revolved until the beveling cut is completed. Wire brushing and hammering removes slag. A windscreen is necessary to assure an even cut.

"Pick-up Work" System

Shop repairs to salvage items is considered "pick-up work," to be done when nothing more important is scheduled. This is the case for two reasons: The first is that an unnecessary duplication of machine tools and other plant equipment is thus avoided. The second, equally important, stems from the fact that mechanical personnel constitute the manpower pool required for all maintenance work in the refinery. Consequently, having pick-up work always available helps smooth out work assignments between major turnarounds, when manpower requirements are the heaviest.

Pan American has not found it satisfactory to send such work as repairing valves to "outside" shops. Mentioned earlier was the $12 original cost as the reparable minimum limit for small valves. On several occasions random samples of small valves have been divided into two batches; half then were repaired by plant shops and the remainder by outside firms. Cost comparisons were in favor of "inside" work and, at the same time, they fixed the limits for economically feasible repairs.

If a shop condemns an article to junk, records are corrected accordingly by the accounting department. When the repaired and tested item is returned from a shop, it generally is painted, marked as worth 80% of its "new" cost and moved to the storehouse. Upon acceptance by the storehouse, "title" passes too, and the salvage yard is credited accordingly. Usually items are not issued for plant use from the salvage yard.

Salvage yard "stocks" of reclaimable articles and scrap are inventoried at least semiannually and preferably every quarter. Strictly Boneyard items are not included in the inventory.

It was mentioned earlier that reconditioned articles are returned to the storehouse with an average value of 80% of original cost. The actual value in practice ranges from 50 to 100% of the new cost. Only in the case of new items damaged during installation is the repaired value ever 100% of original cost. Generally, the repaired value is 80% because that is the average value of secondhand items.

Often such items as valves may be unfitted for their original service but useable under less severe conditions. While the 80% figure still is used, the basis is now not the original cost, but that of a new valve rated for the less severe service.

The accounting operation works as follows: "Salvage Tally" forms are prepared in triplicate for all items received for salvage, giving a description of the items, number received, and value as a per cent of original value. After material appraisal, the original is sent to the central accounting office where the dollar value is entered. When the reconditioned item is delivered to the storehouse the second percentage valuation is recorded on the duplicate tally, which is executed by both salvage yard and warehouse clerks, and is forwarded to central accounting. The third copy is the salvage yard's record for inventory purposes.

Meanwhile, the shop involved has sent to central accounting its "bill" for reconditioning and the completed transaction is adjusted as necessary.

Tallies for scrap are forwarded to the accounting department when the scrap is sold.

As an example, assume a valve is received at the salvage yard worth new $200. By experience the clerk knows reconditioning will cost $75 or $80. (Labor and material). He then assigns an as-received value of 40% ($80), knowing its storehouse value when reconditioned will not exceed $160. (Percentages always are rounded off to the nearest 5%).

Further suppose the valve is condemned by the machine shop when it is inspected for reconditioning, because of extensive internal corrosion. Upon return to the salvage yard it will be revalued by weight as scrap metal, say 110 lbs. of carbon steel, on the duplicate tally sheet. Credit adjustments are made when the transaction is finalized by the accounting department.

The "Boneyard"

The value of a Boneyard to the refinery is great; plant officials say they would not eliminate it even though there is no immediate foreseeable use for many of the items it now contains.

One of many anecodotes about retrieving material from the plant Boneyard centers around the installation of new, special valve-bodies on a critical World War II unit. The old ones had been placed in the Boneyard for possible future use. Suddenly the seat rings on one of the new valve bodies failed. The best of the old bodies was resurrected from the Boneyard, the machine shop installed new seat rings and the unit was off-stream only long enough for the interchange of valve bodies.

Still another tale centers around replacement of the burner on the air preheater at the Fluid unit. The new burner was damaged before the unit came back on-stream following a routine turnaround.

Fortunately this happened between the junk dealer's bi-weekly visits. Someone recalled the old burner might still be in the scrap heap and it was. Repairs and reinstallation took a total of 10 hours, whereas three to four days would have been required for delivery of a new one from the manufacturer. Discarded furnace tubes are routed to the Boneyard, as they can be fabricated into excellent pipe stanchions. A large number of the plant's pipe racks are made from such tubing.

So, while the salvage area and Boneyard are not glamorous and seldom seen or thought of by the usual plant visitor, they pay their way and more. With wartime conditions again returning, their importance to the Pan American refiners may well increase as materials become scarce and deliveries slower.

BETTER WASTE DISPOSAL is secured at the Baytown refinery of Humble Oil & Refining Co. with this effluent distribution system. Water from Black Duck Bay in the background is pumped into the refinery effluent spillway to supply dissolved oxygen and for dilution and cooling of the effluent just prior to disposal

How Waste Disposal Is Supervised In a 260,000 b/d Refinery

THE number and importance of problems connected with the disposal of wastes in the refinery of Humble Oil & Refining Co., Baytown, Texas, which processes around 260,000 bbls. of crude daily, has resulted in a division among various plant agencies of the work of administering the disposal program.

1—The Process Division, which operates essentially all oil processing and chemicals recovery equipment, and the Oil Movements Division, which handles all transporting of oil within the refinery and the loading of common carriers, operate the waste disposal system and maintain its equipment.

2—The refinery laboratory organization is responsible for arranging and conducting the surveys to determine the nature and quality of the effluent stream.

3—A Committee on Waste Disposal, consisting of one representative each from the Engineering Division, the Technical Service Division (which includes the process control engineers) and from the laboratory organization, is responsible for the long-range planning for the plant waste disposal system.

Other Articles

Several refiners over the country, operating both large and small plants, have outlined for PETROLEUM PROCESSING their programs for the administration of their waste disposal systems. Two earlier articles which have included the oil company reports are:

"How Five Refiners Organized Their Waste Disposal Programs," August, 1950, pg. 836.

"More Refiners Describe Their Waste Disposal Program," November, 1950, pg. 1196.

Operation and Maintenance

In the routine operation of the system, the Oil Movements Division operates and maintains the final oil-water separators, the system for chemically treating oils and emulsions recovered from oil-water separators, the sanitary sewage treating plant, and the pump station which delivers cool, oxygen-saturated water from a contiguous bay into the effluent outfall ditch for dilution purposes. The Process Division operates and maintains the unit oil-water separators, the system for chemically treating process emulsions, and all other equipment in connection with the waste disposal system not specifically fall-

ing under the jurisdiction of the Oil Movements Division.

Both the Process and Oil Movements divisions report on waste disposal matters to the Superintendent of Operations, who in turn reports to the General Superintendent at Baytown.

Surveying, Sampling, Analyzing

The Baytown laboratory organization is responsible for surveying, sampling and analyzing the various waste streams for the purpose of obtaining data on the condition of wastes discharged from the refinery, and for use in establishing the need for additional facilities. Pilot unit studies are carried out when this type of work is considered necessary. In the discharge of its waste disposal duties the laboratory organization functions as a staff organization for the plant General Superintendent.

The effluent streams leaving the refinery are sampled three times a week for regular analysis. Daily visual inspections are made, and other samples are taken when it appears that marked changes have occurred in the quality of the effluent. Samples taken on the regular schedule are analyzed for oil content, suspended solids, turbidity, dissolved oxygen, chemical oxygen demand, oxygen demand by dilution and biochemical oxygen demand. The temperature and pH of the effluent are measured each time samples are taken.

Samples taken at less frequent intervals are subjected to analysis for toxic materials and to bacteriological examinations. Three recording pH meters are located at strategic points in the sewer-separator system for the purpose of obtaining a continuous record of the pH of the effluent at these points. One pH recorder is located on the final effluent stream, and the others are located at points that will allow pH adjustment to control the pH of the final stream.

Regular reports on the condition of the effluent are issued every three months, and special reports and letters are sent out whenever it is considered necessary. These reports serve to keep management and others informed on conditions of the effluent and they also constitute a record on these matters. The reports are given wide distribution to management and others who have a real interest or responsibility in waste disposal problems.

When specific problems come to the attention of those responsible for the operation of the waste disposal system, special reports making firm recommendations are sent to the General Superintendent or to other members of the plant management who have authority to put the recommendations into effect. More frequent reports are made to the management group, which meets three times a week to review refinery procedures.

When a condition develops which indicates that some change should be made in the waste disposal system, sufficient survey and other work is carried out to establish definitely what the change should be. This may involve pilot plant studies. After it is decided what changes are required to produce the desired results, a design of the proposed change is made, the cost estimated, and a recommendation made in writing to the proper member of management. It is also common practice to supplement the written recommendation with an oral discussion and recommendation at a group meeting with management.

Long-Range Planning

The chief responsibility of the Committee on Waste Disposal, the third Baytown refinery agency having to do with its problems, is the long-range planning. To this end the committee reviews all data obtained in the investigation of waste disposal problems. It recommends changes and improvements in existing processes which will eliminate or minimize objectionable wastes and it initiates design work on all waste disposal facilities. The policy in general effect at Baytown is that no new plant processing units are installed, and no alterations made to existing units, without the provision of adequate facilities for treating any wastes which may be created, so that they will not adversely affect the quality of the receiving body of water.

The Committee on Waste Disposal follows the general pollution control programs in the Baytown area, and also keeps abreast of developments in the field outside the refinery through attendance at conferences on this subject, and through participation in the work of the committee concerned. Some of the conferences which have been attended by representatives of the Baytown committee include the New England Industrial Waste Conference, Industrial Wastes Conference at Purdue University, Industrial Wastes Conference at Texas A. and M. College, industrial wastes conferences sponsored by the American Chemical Society, the American Institute of Chemical Engineers and the local area Industrial Wastes Conference.

Members of the refinery Committee on Waste Disposal are also active in the work of the API Committee on Disposal of Refinery Wastes, of an inter-company committee on waste disposal, and of a committee of the Houston Chamber of Commerce on waste disposal. Members of management are kept advised as to important information obtained by the Committee through participation in the activities of outside groups, through letters and reports.

The steps which have been recently taken at Humble's Baytown refinery, or are in the process of being taken, in connection with its current sewer-separator modernization and effluent improvement program include:

1—Installation of a sanitary sewage collecting and treating plant.

2—Modernization of the sewer-separator system. This includes installing flight scrapers on the main separator.

3—Elimination of once-through salt water for cooling purposes by making suitable arrangements for fresh water.

4—Cooling and oxygenation of the effluent by dilution with bay water before the effluent is discharged into the bay.

5—Elimination of sludge from treating boiler water from the sewer-separator system.

6—Installation of a flocculation plant for clarifying all dilute non-sulfide-bearing spent chemical wastes.

7—Installation of a precoat filtration plant for filtering sludge from the flocculation plant, sediment from the bottoms of oil-water separators, and refinery slop oils and emulsions.

8—Installation of a plant for collecting sulfide-bearing condensate waters and freeing them of sulfides.

9—Installation of a plant for collecting and concentrating spent caustics for sale to outside customers.

10—Installation of recording pH instruments at strategic locations in the sewer system to facilitate control of pH of the total effluent.

Correction Please

Our attention has been called to an error in the arrangement of material in the article "More Refiners Describe Their Waste Disposal Program" in the November, 1950, issue.

In the description of Richfield Oil Corp.'s program at Wilmington, the last paragraph beginning with "If changes in the waste disposal program . . ." belongs at the end of the description of Socony-Vacuum Oil Co.'s program at Augusta, Kans.

In the description of Socony-Vacuum's program at its Atlas Works, Buffalo, N. Y., the last three paragraphs beginnirg with "The supervisor of the waste disposal system . . ." and continuing with "Constant vigilance is maintained . . ." and "The wholehearted cooperation . . ." belong at the end of the description of Richfield's Wilmington program.

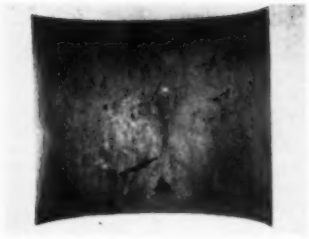


FIG. 1—Inside surface of failed 18-8-Ti cracking still tube. The crack at the center penetrated the 5" OD x .750 wall tube after 9 years service. Many such cracks have been found to originate at inclusions in the steel

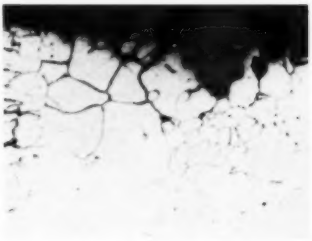


FIG. 2—Intergranular oxidation on outside surface of 25 Cr-20 Ni tube removed from high temperature service. Weld metal is at extreme left

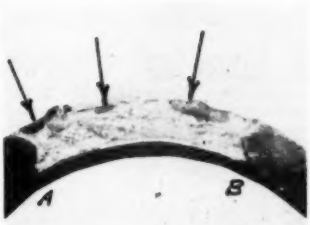


FIG. 3—Fracture along edge of weld in 18 Cr-8 Ni, Cb piping exposed to atmosphere at about 1300°F. Fracture originated 180° from section AB, which did not completely fail but was broken apart by bending. Arrows indicate cracks present on outside surface before complete failure occurred

HIGH TEMPERATURE SERVICE
with Austenitic Steels

Experience in the petroleum refining industry shows there are other factors besides tensile, creep and stress rupture to consider in the use of austenitic steels in high-temperature service. In many applications there is no advantage in using stabilized grades. A spheroidizing heat treatment is generally effective where stabilized steel is required.

The low thermal conductivity and high coefficient of expansion are responsible for many of the failures of austenitic steels in high-temperature service, especially where thermal shock and thermal fatigue are involved.

By M. E. HOLMBERG*
Phillips Petroleum Co.
Bartlesville, Okla.

HIGH temperatures and high pressures, for many years, were associated with improvements in refining processes. In many cases, maximum improvement was impossible because suitable steels were not available to withstand the ever-higher temperatures and pressures. The refineries demanded better high-temperature steels and were quick to use the new alloys developed by the steel industry. It is not surprising, therefore, that the oil industry has a wealth of experience in the use of materials in high-temperature service.

The most severe high-temperature service has been in still tubes, gas-cracking furnaces, and associated piping. Fluid temperatures of 1350° F. have not been uncommon. Pressures as high as 5000 psi. have been used. Metal temperatures of 1450° F. are common. Due to the formation of coke on the inside of tubes, much higher temperatures frequently are encountered unintentionally. Cyclic operations, involving periodic changes in temperatures, have increased the severity of conditions.

This paper is devoted mostly to the austenitic steels because of the recent interest of many in the use of these steels for high-temperature service. Reference is also made to the ferritic steels, which for many purposes have definite advantages. The purpose of

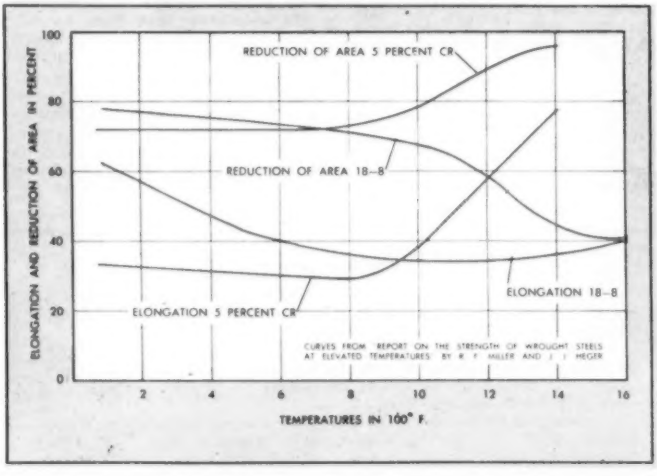


FIG. 4—Ductility-Temperature curves for 5-Cr-Mo and 18Cr-8Ni; illustrating difference in high temperature ductility between ferritic and austenitic steels

*Presented at the Annual Meeting of the American Society of Mechanical Engineers, New York City, Nov. 26—Dec. 1, 1951.

the paper is to call attention to factors that should be considered in using austenitic steels in high-temperature service. It is based on performance of materials in service and examinations of material removed from service.

High-Temperature Properties

The importance and relationship of high-temperature strength, creep, and stress rupture are recognized in high-temperature designs. These might be considered the basic high-temperature properties. If high-temperature equipment does not have sufficient strength at temperature to hold together, if it deforms more than the service can tolerate, or if it deforms and then breaks, the material or the design is obviously unsatisfactory.

As a result of work done by the technical societies and industry, these properties are well understood, and there is now a large amount of high-temperature tensile, creep, and stress-rupture data available. These properties have been discussed so thoroughly by others that further attention will not be given to them in this paper. However, in passing over these basic properties so quickly, it is not intended that their importance be depreciated in any way.

If these important properties are recognized so generally, why then do premature failures still occur in high-temperature service? The answer is that, in addition to these basic properties, there are other factors to consider. The operation of pressure piping and other pressure equipment above 900° F. is relatively new. It is not surprising, therefore, that in some cases the factor that proved to be the most important was overlooked completely in the original design.

In designing one gas cracking furnace, adequate provision was made for tensile, creep, and stress-rupture requirements. In fact, the pressures were so low that these requirements were not too serious, even though the fluid temperature was 1350° F. By using 25 Cr-20 Ni, the design requirements were easily met; yet failures occurred in a matter of days. The 25 Cr-20 Ni had the required high-temperature strength called for in the design, but it did not have the necessary high-temperature abrasion resistance, which had not been recognized even as a factor. Experience showed that strength was not the governing factor, but that abrasion resistance was. Experience further showed that the lower strength 18 Cr-8 Ni was more economical in the service than the 25 Cr-20 Ni.

The intent is not to imply that high-temperature abrasion resistance is a factor that should be considered in every high-temperature application. It probably is of no importance in most cases; but, as in the case cited, it may become the most important consideration. Similarly, experience has shown that certain other factors are important, and those that are likely to prove important in most high-temperature applications will be discussed briefly.

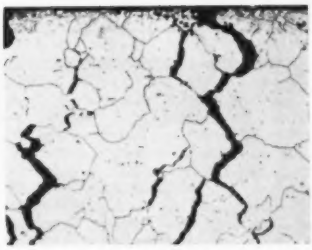


FIG. 5 and FIG. 6—Portion of hot bent 18 Cr-8 Ni Type 304 tube containing surface cracks (left). Cross section of cracked zone shown at right. Note that many of the intergranular cracks do not come to the surface. In some cases the cracks are entirely subsurface. Also note that the high temperature used to bend the tube developed coring at the surface

Stabilized Versus Nonstabilized

Should stabilized or nonstabilized steel be used? This is the first question raised when the use of austenitic steels is considered. A check of the literature, and the manufacturers' data show that, if the steel is to be welded or will operate in the temperature range of 750° to 1550° F., the stabilized grades of austenitic steels should be used. This statement is so often made and is so positive that there seems to be little reason to question it. However, it was intended for and applies to corrosive service. Experience has shown that it does not necessarily apply to high-temperature service.

The "stainless" steels, as the name implies, were developed principally for corrosive service. Most people still do not associate them with high-temperature service. This failure to distinguish between the two types of service is responsible for some of the mistakes. To further confuse the matter, it is of course possible to have corrosive conditions and high-temperature conditions existing simultaneously or at different times in the same equipment.

The first large use of austenitic steels by the oil industry was in still tubes. Corrosion was severe from sulphur compounds in the crudes. Operating temperatures were in the carbide-precipitation range of 750° to 1550° F. It seemed obvious that stabilized tubes should be used, even though no welding was involved. Though titanium-stabilized tubes were used satisfactorily in one installation for approximately 10 years, later experience indicated that plain 18 Cr-8

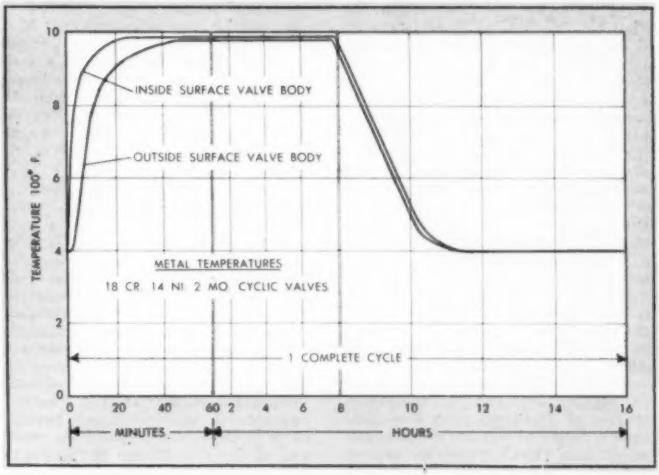


FIG. 7—Curves showing temperatures measured near inside and at outside surface of austenitic valve. Temperature of fluid passing through valve when open was 1000°F.

Ni would have performed equally as well, and possibly even better.

Large tonnages of austenitic steels have been used in gas cracking tubes. Fluid temperatures up to 1350° F. and very high heat inputs exist. Fittings were attached to the tubes by welding. Unlike the still tubes, where pressures were as high as 2500 psi, the pressures in the gas cracking furnaces were less than 60 psi. Again, the conditions indicated stabilized austenitic stainless steel should be used, and it was originally.

In both still tubes and in gas cracking tubes, the inside surfaces often become carburized. When this was discovered, the logic in using stabilized tubes was immediately questioned. Carburization to depths of ¼ in. was common, and analyses showed as high as 3% carbon. It was obvious that columbium or titanium in sufficient quantities to satisfy the original carbon content was ineffective when the carbon content increased as much as 30 times. Test installations and replacements with the nonstabilized austenitic steels showed they were entirely satisfactory.

Here was corrosive service—from the sulphur compounds—and operations within the carbide-precipitation range. Why did not intergranular corrosion take place? The hypothesis offered is that an electrolyte is necessary for intergranular corrosion and that the operating temperatures are too high for an electrolyte to exist. On this basis, installations have been made in other services using nonstabilized austenitic steels. For example, a superheater used to superheat a mixture of steam and air to 1200° F. was made from 18 Cr-8 Ni (Type 304) tubes. This has been in service since June, 1944, and all indications are that the 18 Cr-8 Ni is satisfactory.

There are precautions to be observed when nonstabilized austenitic steels are used in high-temperature service. Even though intergranular corrosion may not develop while the metal is at the operating temperatures, it might at atmospheric temperatures when the equipment is shut down and out of service. If there is a probability that an electrolyte will be present, either stabilized steel should be used or definite action taken to remove the electrolyte during shutdown periods. In the case of still tubes and gas cracking tubes, no precautions have been necessary; but in the case of the superheater referred to, care is taken to see that it is drained during any shutdown.

Why should the nonstabilized tubes be considered for high-temperature service if there is even a remote chance that intergranular corrosion might take place? There are several reasons. Primarily, the use of stabilized tubes may not eliminate failures. Mention was made that nonstabilized tubes may perform even better than the stabilized. The reason

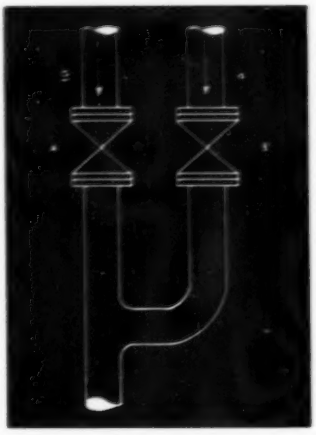


FIG. 8—Piping assembly in which cracks developed in austenitic valves in 10 days, but not in ferritic piping and flanges. Valves alternately opened and closed on 8 hr. cycle. Temperature of fluids was approximately 1130°F.

for this is that the nonstabilized steel is cleaner. Columbium and titanium exist in the steel as nonmetallic inclusions, and the result is essentially a dirty steel. In tubes, these inclusions are elongated into stringers and form surface cracks. Experience has shown that many of the failures in high-temperature service originate at small surface cracks caused by inclusions in the steel (see Fig. 1). Another important reason is cost. The stabilized grades cost approximately 20% more than the nonstabilized grades. Since shortages and restrictions have developed on the use of columbium, it is important that columbium be used only where it is actually needed and not wasted on applications where there is only a remote possibility it will be required.

There are cases where the stabilized grades are required in high-temperature service. For example, it is good practice to use the stabilized grades in the few cases where austenitic steels are required for thermocouple wells. There is usually a temperature gradient over the length of a thermocouple well, and condensation might take place and cause intergranular corrosion. The failure of a thermocouple well can be extremely serious. They are a stock item, and it is undesirable to have too many grades, as it is difficult to control the services in which they will be used. (12 Cr is preferred for thermocouple wells in refinery service as austenitic wells have failed from stress-corrosion cracking where chloride-bearing crudes were being treated.)

The use of stabilized grades does not assure freedom from trouble. As is well known, stress-corrosion cracking can take place in the stabilized as well as in the nonstabilized grades. In high-temperature service, some corrosion is almost sure to be present—at least from slight surface intergranular oxidation. Intergranular oxidation frequently has been observed at the edge of welds. This is generally not serious as it is usually only several grains deep as illustrated in Fig. 2. This intergranular oxidation, together with stress concentration, can be enough in severe cases to cause failure, as in the case of a transfer line in which adequate provision had not been made for expansion and contraction. The 18 Cr-8 Ni-Cb piping, exposed to the atmosphere, conducted 1300° F. hydrocarbon gas. A failure developed at the outside surface as illustrated in Fig. 3. The failure was along the line of stress concentration at the edge of the weld. Metallographic examination showed intergranular oxidation had been severe on the outside surface in the area of stress concentration. When the same pieces were remachined, rewelded, and put back into identical service—but with adequate provision made for expansion and contraction—no further trouble was experienced. A larger plant was later built using straight 18 Cr-8 Ni and, by making adequate provision to avoid stress concentration, stress-corrosion (oxidation) cracking was not experienced.

Even where temperature and corrosive conditions are such that stabilized grades are desirable, it is often satisfactory to use nonstabilized grades. This can be accomplished by giving the finished assembly a stabilizing heat-treatment. Where service exposes austenitic steel above 750° F. the usual solution heat-treatment (2000° F. and quench) will not be satisfactory, as the carbides will precipitate out in service. In such cases, a spheroidizing heat-treatment is to be preferred and is effective, especially in fine-grained steel. This treatment consists of heating to 1525-1650° F. for a time long enough to precipitate the carbides along the grain boundaries and for diffusion to spheroidize the carbides so that they will not form a continuous chain. In addition, the time at temperature permits the chromium to diffuse and replace the chromium in the chromium-depleted zone along the grain boundaries. Eight hours at 1525° F. is sufficient. By going to 1650° F. the time can be reduced to 2 hr. This heat-treatment is simpler than the solution heat-treatment and has been found to be effective for conditions encountered in the oil industry. Some sigma phase might form, but this is not serious. Sigma phase has been observed in 18 Cr-8 Ni and 25 Cr-20 Ni for 10 years, and no mechanical failure has been observed in austenitic steel

that could be attributed to sigma phase.

Stress Relieving

Stress-relieving the austenitic chromium-nickel steels should not be considered on the same basis as the carbon steels. The two steels are different. The austenitic steels do not pass through a transformation temperature during welding and are not hardenable. Heating the austenitic steels to 750-1550° F. results in carbide precipitation, which has an adverse effect on corrosion resistance. Harmful carbide precipitation does not take place in the carbon steels in this manner.

Thermal stress-relieving of carbon steel is beneficial in two ways: (1) it reduces stresses, and (2) by tempering, it improves the physical properties. Brittle steels with low ductility are benefited most by stress-relieving heat-treatment, both by the reduction of stresses and the improvement in physical properties.

The austenitic chromium-nickel steels are extremely tough and very ductile, and therefore do not require the improvement in physical properties so often needed in welded carbon steels. Moreover, stress-relieving does not improve the properties. Instead, if anything, stress-relieving has an adverse effect by precipitating carbides. The only benefit to be derived from stress-relieving the austenitic chromium-nickel steels is a slight reduction in stresses. This reduction for most stress-relieving treatments will be small because of the high elevated-temperature strengths of the austenitic chromium-nickel steels.

If corrosion resistance is a reason for using the austenitic chromium-nickel steel, the loss in corrosion resistance due to carbide precipitation during stress-relieving may be serious enough to make the austenitic steel utterly unsatisfactory for the intended service. The harmful effect of intergranular corrosion may be greater than any benefits derived from a slight reduction in stresses. It should be noted that some carbide precipitation might take place even though the stabilized grades are used.

If, for some reason, the austenitic chromium-nickel steels must be stress-relieved, the stabilizing heat-treatment of 1550-1650° F., previously described, should be considered. This treatment will more effectively relieve stresses than a lower temperature, and will give the additional advantage that stabilization of carbides will result.

Expansion and Contraction

The austenitic steels have a coefficient of expansion approximately 1½ times that of steel. If adequate provision is not made for this added expansion and contraction, failures will develop in high-temperature service. Failures are quite likely to be in the form of stress-corrosion cracking. Reference was made previously to such failures in the discussion of stabilized steel. The high coefficient of expansion may not cause failure in itself, but it does have a great influence on most failures associated with high-temperature service by aggravating and increasing the effects of any other weakness or undesirable property.

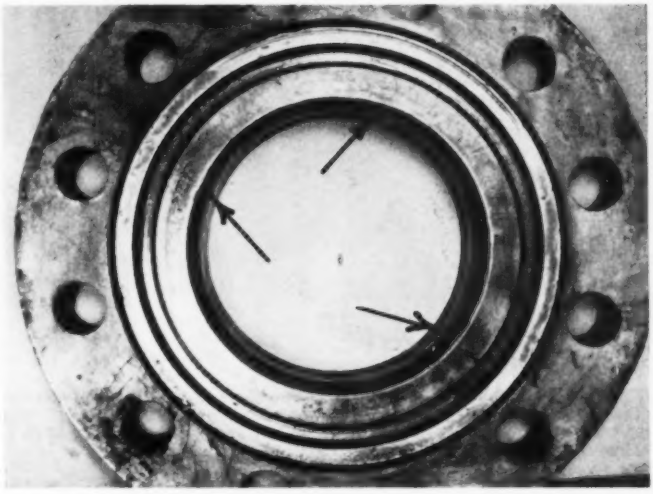


FIG. 9—View of flange face showing some of larger cracks in austenitic valves used in piping assembly illustrated in Fig. 8

In high-temperature service, cracking is often associated with the high coefficient of expansion. Wherever an austenitic steel is tacked down and held in place, cracking is likely to occur whether the material is stabilized or nonstabilized. In one assembly, the tubes were tacked in place. After about 2 years of service, cracks developed on the outside surface at each tack. The tacks were cut loose, the cracks repaired, and equipment put back into service with the tubes free to distort. No further trouble has been experienced, and the equipment has been in service 4 years since the tacks were cut loose.

Hot Shortness

The strength of steel decreases as the temperature is increased. With the decrease in strength, in ferritic steel, there is an increase in ductility. This is not true with austenitic steel. The ductility of austenitic steel decreases as the temperature is increased to about 1600° F. Between about 1600 and 2200° F. there is an improvement in ductility. This difference between ferritic and austenitic steels is illustrated in Fig. 4.

The ductility of austenitic steel at elevated temperatures is misleading. The values look good in spite of the fact that they are somewhat lower than the high values for atmospheric temperature. What the curves and data fail to bring out is that, between about 1000 and 1800° F., severe deformation or bending develops intergranular cracks. Furthermore, above about 2200° F. the austenitic steels are extremely hot-short. Steel companies and others who regularly hot-form the austenitic steels are aware of these hot-short characteristics. They know that there are only narrow temperature ranges in which these steels can be hot-worked or formed. Most users of austenitic steels and many fabricators do not recognize these hot-short characteristics.

This hot shortness is important. During fabrication it is common practice to heat piping and other shapes prior to bending. Without careful temperature control, there is a danger of forming intergranular cracks (see Figs. 5 and 6.) These cracks are usually extremely hard to detect—they may not even reach the surface—with the result that defective material may be put into service. When operating equipment made from austenitic steel in the temperature ranges where intergranular cracks might form, every effort should be made to keep deformation to a minimum. It is suspected that some high-temperature stress cracks may be actually hot-short cracks. In the oil industry there are numerous operations in which carbon is periodically burned off catalyst or metal surfaces. If not controlled properly, temperatures high enough to melt the austenitic steels can be reached. When extremely high temperatures inadvertently

FIG. 10—Samples used to show effect of thermal conductivity and thermal coefficient of expansion on crack formation. The upper 18 Cr-12 Ni sample was given a stabilizing treatment of 24 hrs at 1565°F. before being exposed to the heating and cooling cycles. Arrows indicate location of cracks in the 18 Cr-12 Ni samples

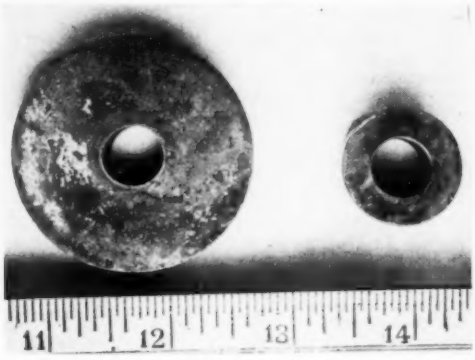


FIG. 11—Samples used to show effect of size on crack formation. Cracks were in bore of the larger sample at the end of 50 cycles; none was found in the small sample at the end of 100 cycles

develop, any deformation may result in hot-short cracks.

Thermal Conductivity

The thermal conductivity of austenitic steel is low, being about one half to one fourth that of ferritic steel. This results in steep temperature gradients, and uneven heating causes hot spots that tend to be localized. Sudden changes in temperature cause parts to be hot while adjacent parts are cool, and it takes longer for temperatures to become equalized. In passing, it is of interest to note that the low thermal conductivity of the austenitic steels probably accounts for workmen, accustomed to dealing with carbon steel, overheating the austenitic steels. Evidence of the extreme temperature gradients that are so easily developed is illustrated by the coring at the surface in Fig. 6.

In cyclic operations, where equipment is alternately hot and cold, the temperature gradients can be very steep. When a cold valve opens quickly and hot fluid passes through it, the inside surface immediately becomes hot, while the outside is cold and requires some time before it becomes heated. This is particularly true of thick sections such as flanges. Temperature measurements made on an austenitic valve in cyclic service are plotted in Fig. 7. This illustrates the temperature gradients that can develop, and that the temperatures may never reach equilibrium in service.

What are the effects of these temperature gradients? Hot spots or local heating in thin material result in warpage. When the sections are larger and deformation does not occur, stresses are set up. The steeper the temperature gradient, the greater the stresses. Also, the steeper the gradient, the more localized are the high stresses. Again, the high coefficient of expansion of the austenitic steels aggravates the difficulties resulting from the low thermal conductivity.

Heating and Cooling

Experience has shown that much of the trouble with high-temperature service occurs during heating or cooling. When equipment is being brought on stream and is heating up, leaks are likely to develop in piping systems. When it cools down, other leaks and even breaks may develop. Less trouble is experienced with equipment that operates steadily at temperature than that which requires shutdowns. Unfortunately, most high-temperature equipment in refineries requires periodic shutdowns—for example, every 90 days—for cleaning or other maintenance operations. As a result, refineries have become conscious of the difficulties associated with heating and cooling.

Within the past 10 years many cyclic processes have been introduced. In these, the equipment operates for a period of time at one set of temperature and pressure conditions, and then for another period at a different set of conditions. In some of these cyclic operations, the high-temperature failures have been almost spectacular and have resulted in frequent reference to such terms as "thermal shock" and "thermal fatigue."

Thermal Shock

Thermal shock is not new. Its effects long have been recognized in the failure of rolling-mill rolls, gun barrels, brake drums, and other equipment subject to sudden applications of heat. With the advent of thermal cyclic processes, thermal-shock failures have come to be recognized in certain high-temperature piping and fitting installations.

Fig. 8 illustrates a piping assembly in which thermal-shock failures occurred. The piping and flanges were 5-Cr-Mo, but the valves were 18 Cr-12 Ni. For 8 hours valve A was open and B closed. The fluid temperature of the hydrocarbons passing through A was 1150 F. At the end of 8 hours, valve A closed and B opened. Steam and air at 1120° F. passed through B for 8 hours and A gradually cooled down. Valve B then closed, valve A opened, and the cycle repeated itself. When this plant was put into operation, at the end of 10 days cracks were found at the flange face of valve A radiating from the bore and extending back into the bore approximately the thickness of the flange. Similar cracks were found in valve B shortly thereafter. These cracks soon extended into the ring groove and are shown in Fig. 9.

The cracks formed as follows: While closed, the valves slowly cool down. When they open, the inside surface is exposed to high-temperature fluid and instantly becomes hot to a shallow depth, while the outside is still cool. The inside surface tends to expand, but is restrained by the cool outer mass of metal. Instead of expanding, the inside is compressed or upset. Then, as the outer mass gradually heats up, the inside is put into tension. It should be noted that the cracks first formed at the flange where the restraining mass of metal and the differences in temperature were greatest. Experience showed that only a few cycles were required to develop cracks in 18 Cr-12 Ni valve flanges, but that the 5-Cr-Mo flanges of the same size and 5-Cr-Mo piping

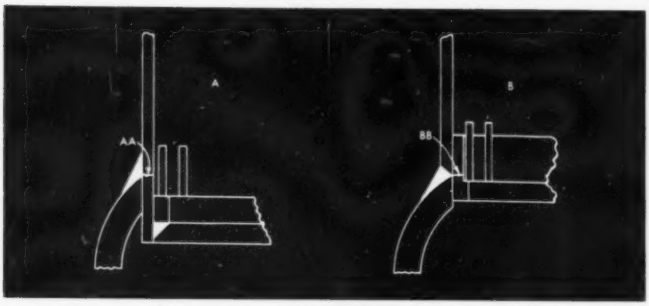


FIG. 12—Sketch showing details of grid, tube, header assembly. Failures develop at AA and BB in assemblies made from austenitic steels

FIG. 13—End of 25 Cr-20 Ni tube containing grid. The tube failed along AA of Fig. 12

could withstand many identical cycles.

The superiority of the ferritic over the austenitic steel is believed to be due to the differences in thermal conductivity and coefficient of expansion. The higher thermal conductivity of the ferritic steel results in lower temperature differences between the inside and outside surfaces; hence lower stresses. Similarly, the lower coefficient of expansion of the ferritic steel results in lower deformation and less restraint between the two surfaces. Again, the result is—less stress. These two factors combined result in appreciably less stress and longer life in the ferritic than in the austenitic steel. This experience has been confirmed in several installations where ferritic steels have performed better than austenitic steels in thermal cyclic operations. In the case cited, replacement valves made from 9-Cr-Mo gave excellent service.

Thermal-shock failures occur, of course, in ferritic steels as well as in austenitic steels. In the foregoing installations, where austenitic flanges in the valve cracked in 10 days, several small cracks were found in the mating 5-Cr-Mo flanges of the same size at the end of 2½ years.

To demonstrate the mechanism of such failures, a simple test was made. Samples of 18 Cr-12 Ni, 12 Cr, and plain carbon (SAE 1035) steels were machined as shown in Fig. 10. The bores were heated with a torch to a dull red heat. Holding the bore at heat, the entire piece was then brought up to a dull red heat. The piece was then cooled to room temperature. At the end of 16 cycles, the austenitic 18 Cr-12 Ni had developed cracks at the bore. Ferritic steels, SAE 1035, and 12 Cr, subjected to the same cyclic treatment 32 times did not develop any cracks. At the end of 32 cycles several cracks had formed in 18 Cr-12 Ni that had previously been given a stabilizing heat-treatment of 24 hours at 1565 F.

To demonstrate the effect of size on crack formation, two samples of 5-Cr-Mo were machined as shown in Fig. 11. The diameter of the bore of these pieces was ½ in. The outside diameter of the smaller piece was 1 in., and that of the larger, 2 in. The bore was heated with a torch to a dull red heat. While keeping the bore at temperature, the rest of the piece was brought to a dull red heat. The cycle was completed by blowing air through the bore until the bore had lost all visible heat. In view of the inaccuracies of visual control, the temperature extremes reached by this process probably were within the range of 800 to 1300° F. At the end of 50 cycles many small cracks were found in the bore of the larger piece. Even after 100 cycles, the small specimen showed no cracks. The heavier the section, the more readily it cracks.

Thermal Fatigue

The examples used to illustrate thermal shock might also be considered thermal fatigue, as a number of cycles were required to produce failure. However, since so few cycles were required to produce failure and the rapid heating was such an important factor, they were classified as primarily thermal shock rather than thermal-fatigue failures. Cyclic changes in temperature can cause changes in stress and produce thermal-fatigue failures without thermal shock; but the rate of temperature change is often closely related to the stresses induced.

Fig. 12 shows two methods used to attach vertical tubes to a header. At the bottom of the tube is a grid, which supports catalyst. The juncture of the tube and the lower header repeatedly goes through a rather complex heating cycle approximately as follows: 1 hour at 1150° F., followed by 1 hour starting at 1050° F. and increasing to 1450° F, and finally dropping down to 900° F.

Serious failures developed in a year at AA in austenitic steel using detail A. Such a failure is shown in Fig. 13. An unimportant, but significant, cracking was found in 2½ years at BB in austenitic steel assemblies using detail B. No failures developed in detail B when the assemblies were made from ferritic steels. Assemblies of 27 Cr and of 7-Cr-Mo both gave good service in so far as detail B was concerned. The 27 Cr became extremely brittle in service and many failures occurred, but they were not associated with the design of the assembly. In making 27-Cr tube replacements, assemblies approaching detail A were listed successfully.

The failures in the austenitic steel (25 Cr-20 Ni) have been classified as thermal fatigue. As the equipment passes through the different cycles, the end of the tube protruding into the header expands, is restrained and slightly upset, cools and contracts. The alternate bending results in the formation of cracks and the tube end breaks off. Note that the cracks at BB correspond to the condition at AA. The freedom from failure in the ferritic steels is believed to be due to their higher thermal conductivity and lower coefficient of expansion. It is also suspected that the bending of the austenitic steel in a hot-short temperature range contributes to the failure.

Conclusions

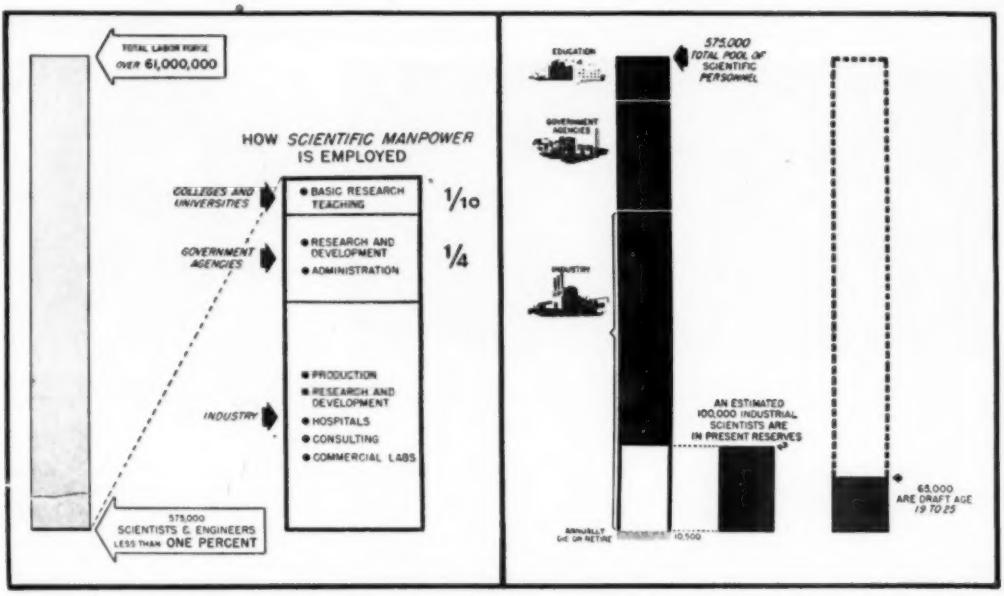
1—Stabilized austenitic steels are not required for gas-cracking and still tubes.

2—A spheroidizing heat-treatment is adequate for many oil-industry applications requiring austenitic steels in the stabilized condition.

3—Stress-relieving austenitic steels can seldom be justified, unless stress-corrosion cracking is known to occur.

4—The hot-short characteristics of austenitic steels should be considered in high-temperature design.

5—The low thermal conductivity and high coefficient of expansion are responsible for many of the failures of austenitic steels in high-temperature service, especially where thermal shock and thermal fatigue are involved.



SCIENTIFIC MANPOWER—a small but highly critical part of America's total labor force . . .

. . . A CRIPPLING PROPORTION of which could be lost to unspecialized military service

Program for Strategic Use of Scientific Manpower in All-Out Mobilization

A BROAD plan to insure the efficient and strategic use of the nation's scientific manpower in the present mobilization program has been prepared by a Scientific Manpower Advisory Committee of the National Security Resources Board. The plan also provides for maintaining in the years ahead a flow of adequately trained scientific manpower from the colleges to industry, the military and for other essential uses. It applies both to inductees under Selective Service and to present military reservists.

The Committee's recommendations are based on the premise of universal military service for youths reaching the age of 18. They recognize the relatively small reservoir of scientifically trained manpower in the country available to both industry, the military and for all other uses. The program therefore emphasizes the importance of making the most efficient use of this manpower if the nation is to continue the industrial achievements in turning out war materials which serve to offset the nation's deficiency in total manpower as compared with that of our enemies.

The words "scientific manpower," by definition in the report, include scientists, engineers and "other technical personnel". The Committee report states in its foreword that, although no recommendations are made with reference to technicians "their extreme importance is recognized in support of work at the professional levels."

The NSRB Committee's plan for the development and use of scientific manpower was presented before the Senate Committee on Armed Services, at its hearings in Washington on the subject of the new military training law which will replace the present Selective Service Act expiring in July. The Committee is composed of 12 leaders in science, education and in industries which are large users of engineers, chemists and other professionally trained personnel. C. A. Thomas, executive vice president of Monsanto Chemical Co., is chairman; E. V. DeGolyer, well known geologist and producer, is the petroleum industry representative.

"In terms of gross numbers of men, the U.S. is inferior to its potential enemies", states the introduction of the report. "The last war, however, proved that weapons incorporating the latest developments in science and engineering, combined with fruitful research and mass production, gave this nation a marked advantage.

"The present problem then is to create a plan that will assure a continuing supply of men with special training, and to devise a method that will secure the best use of them as well as those who are already trained. The Committee recognizes the following needs for scientific personnel.

"1—Military: For research, training, operations and maintenance in phases of technological warfare.

"2—Industry: For research relating to the design and development of products for both military and civilian use, and for the rapid translation of new weapons, materials and equipment into mass-produced finished products.

"3—Research: To be in the forefront of scientific advancement, the nation depends upon highly trained people for research, both basic and applied—in industry, in government, in colleges and universities and in research institutes.

"4—Civilian: Scientifically trained manpower is needed to further the work of education, agriculture, public health, civilian defense and public welfare."

The two principles upon which any plan for obtaining the best use of scientific manpower should be based are stated as (a) the judicious distribution of the available scientific manpower among those activities in which scientifically trained men can make the most effective contribution to the strength of the nation and (b) maintaining a continuous flow of adequately trained scientific manpower from the colleges and universities.

The NSRB program has three recommendations:

1—Long-range plan for the selection and training in science of youths inducted for military service, and a temporary plan to tide over the interruption of the flow of students to colleges until the long-range plan becomes fully operative.

2—Establishment of a National Scientific Personnel Board, and regional boards, of persons qualified to defer men from military service for study in science or to serve industry.

3—Establishment of special provisions for handling present reservists having scientific and technical skills.

Recommendation No. 1

In addition to the established Reserve Officer Training Corps at the college level, a Reserve Specialist Training Corps would be set up to provide a continuous flow of men, most of whom would be trained in science, engineering, medicine and other critical fields, and who would then be available for military and civilian activities essential to national strength.

Candidates for the RSTC would be selected by a board of competent educators with both civilian and military representation. Selection would be made on the basis of competitive examinations, adjusted by other indications of aptitude or attainment.

The size of the RSTC would be reviewed periodically by the National Scientific Personnel Board (as provided in Recommendation 2), in the light of fluctuating requirements. At present, the Committee believes that initially the number of annual entrants needed would be approximately 75,000. After the men not elected or qualified for RSTC or ROTC have completed their 27 months of military service and begin to flow back to the colleges, the initial number required for RSTC could be reduced.

RSTC members, upon completing their training in school, would be liable for the completion of the remaining portion of their military training and service period of 27 months except that, upon recommendation of the National Scientific Personnel Board, they might discharge all or a part of their liability for military service in other activities essential to the national defense.

A temporary plan is suggested for building up the numbers of college trainees until the long-range plan is in full operation. This calls for allowing juniors and seniors in good scholastic standing to complete their college courses and graduate before being called for military training, and for selected graduates to enter graduate training, as approved by the National Scientific Personnel Board

Recommendation No. 2

At present, the report on the development and use of scientific manpower points out, there are about 65,000 scientists and engineers of age in the country, representing less than 1% of the civilian male population in this draft group. A large portion of these are already employed in work of vital importance to the nation. The report recognizes that a portion of these should be inducted and assigned to special military assignments which will make best use of their training and experience. "It is most vital", the report continues, "that these trained scientists and engineers are not removed from defense activities for service in nonspecialized military assignments".

The Selective Service System, it is pointed out, is not organized to establish the criteria to evaluate the importance of the present work of men with scientific training, nor do the local draft boards have the technical knowledge to judge the cases of individual registrants. The report urges, therefore, that a National Scientific Personnel Board be created, to function at the highest level in the Office of Defense Mobilization. The personnel of the board would be such that it could bring to bear upon scientific manpower problems both a technically competent and a broad national point of view. Component elements of the board would be regional scientific personnel boards.

The functions of the national board would be: To determine the requirements for scientific manpower of the armed forces and other activities essential to the national strength; to classify the skills in science, engineering and technology which are of special importance to national strength; to develop criteria for identifying and classifying persons possessing these skills; to advise on the number of scientific and engineering students to be selected for the Reserve Specialist Training Corps; to allocate the requirements of the Armed Services for scientific manpower to regional boards for filling; to decide appeals filed by regional boards, Selective Service, by individuals or by employers.

Principal duties of the regional boards would be to classify individuals possessing critical scientific and engineering skills who are liable for military service, and to fill the requisitions of the Armed Services for scientific and technical manpower and to assign a deferred classification to registrants possessing critical scientific skills required in defense industries or other essential but non-military activities.

Recommendation No. 3

This part of the report recognizes the problem of making the proper strategic use of the large numbers of scientists and engineers who now possess military reserve status, and establishes special provisions for handling reservists. The danger of loss of reservists with technical and scientific skills is particularly acute, it is pointed out, if the present machinery of mobilization removes these individuals from essential industrial occupations.

"Because of G.I. training privileges", it is stated, "the lapse of time since their last active duty, and obsolescence of certain military specialties—indiscriminate callup, much more than ever in the past, would blunt their effectiveness in the military and would impede industrial mobilization. Large numbers of these present reservists are key figures in research, industrial development, production and education."

Recognizing that this problem is the responsibility of the Department of Defense, it is urged that the Department set up machinery with the following functions for handling present reservists:

1—To develop policies which will be reconciled with the needs for scientific manpower for essential educational, research and production activities.

2—To act on appeals from individual technologists or their employers.

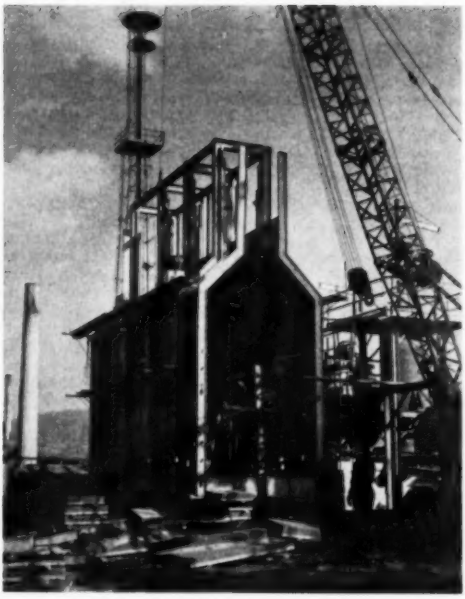
3—Set up a clearance agency where employing establishments can review their needs for retaining reservists in their organizations and obtain clearance on reservists.

4—Clarify to employers the importance of their notifying the Armed Services of their needs for specific reservists.

5—To develop a policy relative to calling up present reservists who are advanced undergraduate or graduate students in critical fields, in order that their skills may be used in a manner which will make the greatest contribution to national security.

How to Get the Report

Copies of the complete text of the Plan for the Development and Use of Scientific Manpower, of the Scientific Manpower Advisory Committee of the National Security Resources Board can be secured by writing the Board's headquarters, Old State Department Bldg., 17th St. and Pennsylvania, Washington 25, D. C.



THIS MONTH'S COVER PICTURE . . . .

. . . shows the furnace installation for Kendall Refining Co.'s new 1,500 b/d Platforming unit, now under construction at their Bradford, Pa., refinery. The furnace is novel in that there are three separately fired heater sections with a common convection bank. The furnace is divided longitudinally by a center wall and one of these divisions is again divided by a transverse wall, thus making one large and two small heating chambers. The mixed stream of charge stock and recycle gas passes through the convection bank and the large heating chamber and then into the first reactor. Leaving the first reactor, it passes through one of the small heating chambers and then into the second reactor. From the second reactor it passes through the other small heating chamber and then into the third reactor.

This arrangement of the three heating operations in one furnace provides economy of investment and operating cost, while at the same time maintaining all essential flexibility.

Construction of the furnace is cast refractory panels on steel plates. As shown here, most of the steel plates are in position, with the refractories about to be installed. The tube bundle which appears in the convection bank will be raised into the upper narrow portion of the structure.

Photo courtesy H. V. Smith
Refinery Manager, Kendall Refining Co.

AROMATICS BY PLATFORMING

The Platforming process has been found suitable for the conversion of C_5 and C_6 ring naphthenes to benzene, toluene and C_8 aromatics. For maximum yields modifications are made in charge stock and operation, from conditions for producing high-octane motor fuel. Processing a 150-190°F. fraction from a West Coast crude in a laboratory scale unit resulted in a 48 wt.% potential yield of benzene, the residual paraffinic material being valuable from a motor fuel standpoint.

By VLADIMIR HAENSEL and CHARLES V. BERGER
Universal Oil Products Co.
Riverside, Ill.

THE national emergency has resulted in a greatly increased demand for the lower aromatic hydrocarbons, which were in short supply even before the emergency. These include benzene, used principally in the production of synthetic rubber, plastics and a variety of essential chemicals; toluene for aviation gasoline and explosives; and C_8 aromatics which are utilized in aviation gasoline and in the paint and chemical industries.

The availability of large quantities of hydrocarbons from the petroleum industry makes it a logical source of raw materials for the production of these aromatics. The Platforming process has been found to be ideally suited for the conversion of these hydrocarbons to the desired aromatics.

The production of high octane motor fuel by Platforming has been described previously[1, 2] where it was indicated that one of the major reactions of the process is the formation of aromatic hydrocarbons. It is possible to separate the aromatic hydrocarbons from the motor fuel Platformate; however, when maximum yields of C_6-C_8 aromatics are desired,

Meet the Authors

Mr. Haensel

Vladimir Haensel since 1945 has been co-ordinator of the Cracking Research Division of Universal Oil Products Co. He received his B.S. from Northwestern University in 1935 and his M.S. from MIT in 1937. He joined UOP, where he assisted Prof. V. N. Ipatieff. He received his Ph.D. from Northwestern in 1941 and returned to Universal as a research chemist. As a member of the Technical Oil Mission for PAW he inspected the German synthetic oil plants in 1945.

Mr. Berger

Charles V. Berger is a member of the UOP Engineering Research and Development Department, working on catalytic cracking and catalytic reforming. He received a Chemical Engineering degree from the University of Minnesota and joined Universal, working first in the Riverside Laboratories and later in the Patent Department. During the war as a member of the Service Department he assisted in starting up aviation gasoline plants in Arkansas, Wyoming and Bahrein.

modifications are made in the choice of charge stock and the operation of the process. The present paper reports the work on the production of aromatic concentrates using the Platforming process. The results were obtained in laboratory, pilot plant and commercial operations.

Availability of Feed Stocks

In the Platforming process aromatics are formed primarily from the naphthenes in the charging stock. Exhaustive analyses have been made in recent years of light straight-run naphthas from representative gasolines produced in many sections of the U. S. Tabular information on the "C_6" and "C_7" fractions of these naphthas are shown in Tables 1 and 2. The "C_6" and "C_7" fractions are taken by boiling range as shown in the tables, therefore, the "C_6" fraction contains some low boiling heptanes. It will be noted that, for example, in the "C_6" fraction, the naphthene content can vary from 20% to 55% and in the "C_7" fraction from 25 to 75%. The concentration of natural aromatics in these fractions also varies considerably. Very little information is available on the concentration of individual naphthenes in the "C_7" fraction. However, both hydrocarbon type analysis and experience indicate that the naphthene content in the "C_8" cut is about the same as in the "C_7" fraction.

Theoretical Considerations

An ideal process for the conversion of naphthenes to aromatics should have the following characteristics:

1—The catalyst should possess the power to convert both C_6 and C_7 ring naphthenes to aromatics. If only the C_6 rings are converted, approximately half of the potential aromatics are lost.

2—Since dehydrogenation of naphthenes is an equilibrium reaction controlled by temperature, pressure, and hydrogen partial pressure, conditions of operation must be in a region in which the equilibrium is greatly in favor of the aromatics.

3—Operating conditions and catalyst properties must be such that undesirable and relatively irreversible side reactions such as ring opening and demethylation are minimized.

4—Long catalyst life is economically necessary, and for this reason operating conditions and catalyst properties must be such that catalyst carbonization is avoided.

Furthermore, since the reaction is endothermic to the extent of about 1000 BTU/lb. naphthenes converted, heat must be supplied to the reaction to obtain high conversion at reasonable space velocities.

The Platforming process satisfies all these requirements since the catalyst will convert both C_6 and C_7 naphthenes to aromatics, will not promote undesirable side reactions, and does have a long non-regenerative life at conditions at which the naphthene-aromatic equilibrium is highly favorable to aromatic formation. Heat of reaction is supplied by proper process design.

Results

Benzene Production: The following experimental results were obtained when processing in a laboratory scale unit a 150-190° F. fraction separated from a West Coast crude. This particular operation was carried out using an apparatus comprising a reaction tube enclosed in an aluminum bronze block, a liquid-gas separator and a recycle gas system. Previous work on a unit of this type indicated a good correlation between the results obtained in this unit, pilot plant operation, and commercial operation.

Table 3 gives a charge stock analysis as well as complete product distributions from runs made at various severities.

The above data indicate that high yields of benzene can be realized by this operation. The residual naphthene content in the product was not determined in this particular series of runs; therefore, the efficiency of conversion of naphthenes to aromatics cannot be given other than to state that it must be in excess of 92%, since that value corresponds to the highest yield obtained. Such a calculation assumes, of course, no formation of benzene from C_6 paraffins, which has been found to occur to only a minor extent. Similarly, since the naphthene content of the C_7 component of the charge is not known, no efficiency value of con-

TABLE 1—Composition of 140-185°F. Fractions from Various Straight-Run Gasolines[3]

	Source						
Hydrocarbon, Vol. %	Ponca Okla.	East Texas	Bradford Pa.	Greendale Mich.	Winkler Texas	Midway Calif.	Conroe Texas
2-methylpentane	9	15	22	7	17	14	11
3-methylpentane	8	12	13	5	42	10	8
n-hexane	41	31	37	63	11	16	17
2,2 & 2,4 dimethylpentane	2	6	6	2	8	4	3
Methylcyclopentane	20	23	9	9	15	34	21
Cyclohexane	16	12	12	11	6	21	31
Benzene	4	1	1	3	1	1	9
Total naphthenes	36	35	21	20	21	55	52
% of 140-185° F. fraction based on C_6-360° F. Gasoline	13	16	15	18	10	12	14

TABLE 2—Composition of 185-220°F. Fractions from Various Straight-Run Gasolines*[3]

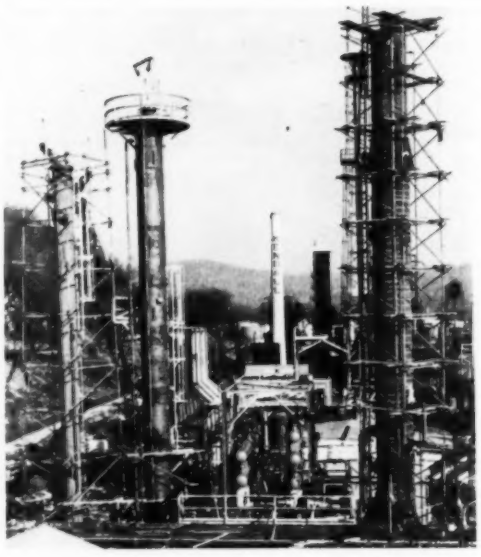
	Source						
Hydrocarbon, Vol. %	Ponca Okla.	East Texas	Bradford Pa.	Greendale Mich.	Winkler Texas	Midway Calif.	Conroe Texas
2,3-Dimethylpentane / 2-Methylhexane	14	14	15	8	31	11	9
3-Methylhexane	4	5	6	2	25	3	2
n-Heptane	29	19	31	56	9	6	12
1,1 Dimethylcyclopentane	2	2	2	2	4	3	2
tr 1,3-Dimethylcyclopentane	15	16	6	3	10	26	6
tr 1,2-Dimethylcyclopentane	5	6	6	1	8	10	1
Methylcyclohexane	21	27	24	18	10	30	36
Ethylcyclopentane (est.)	(3)	(4)	(4)	(3)	(1)	(5)	(5)
Toluene	7	7	6	7	2	6	27
Total naphthenes	46	55	42	27	33	74	50
% of 185-220° F. fraction based on C_6-360° F. Gasoline	23	25	24	23	15	20	27

* Including all the natural toluene, part of which tends to appear in this fraction because of a tendency to be more volatile in the presence of other hydrocarbons.

TABLE 3—Processing of 150-190°F. Cut from a West Coast Stock over the Platforming Catalyst

Charging Stock	Wt. %	Potential wt. % benzene yield
Hexanes	27.7	
Methylcyclopentane	36.6	44.4
Cyclohexane	11.3	
Benzene	3.6	3.6
C_7 naphthenes and paraffins	20.8	
	100.0	48.0

	Increasing Severity of Operation				
Product Composition, Wt. % of Charge	I	II	III	IV	V
Gas: H_2	3.0	3.0	3.0	3.1	3.1
CH_4	0.3	0.2	0.4	0.3	0.5
C_2H_4	0.5	0.6	0.9	0.8	1.1
C_3H_8	0.7	0.8	1.2	1.0	1.3
C_4H_{10}	0.3	0.4	0.5	0.6	0.7
C_5H_{12}	0.0	0.1	0.0	0.1	0.0
Liquid Product:	95.2	94.9	94.0	94.1	93.3
Total	100.0	100.0	100.0	100.0	100.0
Benzene, Wt. % of charge	36	38	39	41	44
Toluene, Wt. % of charge	12	12	13	13	15
Benzene % yield of theoretical	75	79	81	85	92



64,550 b/d of Platforming Capacity

Since the first commercial Platforming unit went on stream in October, 1949, at the plant of Old Dutch Refining Co., Muskegon, Mich., an additional 12 units have been sold in this country and Canada and are now under construction or being designed. Their total combined charge capacity will be close to 65,000 b/d.

Location	b/d
Old Dutch Refining Co., Muskegon, Mich.	1,500
Kendall Refining Co., Bradford, Pa.	1,500
Bell Oil & Gas Co., Grandfield, Okla.	1,500
Johnson Oil Refining Co., Cleveland, Okla.	1,850
Mid-West Refineries, Inc., Alma, Mich.	1,500
Premier Oil Refining Co., Ft. Worth, Texas	1,500
Shell Oil Co., Houston	16,000
Shell Oil Co., Wood River, Ill.	16,000
Aurora Gasoline Co., Detroit, Mich.	4,500
Petroleum Specialties, Inc., Detroit, Mich.	900
Taylor Refining Co., Port Isabel, Texas	4,000
Standard Oil Co. of California, El Segundo, Calif.	10,000
Canadian Oil Refineries Ltd., Froomfield, Ont.	3,800
TOTAL	64,550

In addition, a 1,500 b/d unit is being installed for Bitumen & Oil Refineries Ltd., in Australia.

Shown at left is a general view of the unit under construction for Kendall Refining at Bradford, Pa. The Platforming reactors are just visible behind the bank of heat exchangers in the left foreground.

version to toluene can be given. The data do indicate, however, that the conversion to toluene must be very high, since out of the total 20.8% C_7 naphthenes and paraffins present in the charge, the toluene concentration in the product ranged from 12 to 15% by weight of the charge.

An important point in connection with the production of benzene by the Platforming process concerns the value of the residual material after benzene removal. In a normal operation the aromatic-free residue is blended into motor fuel. Since this residual material amounts to one-half or more of the original charge, the composition of this material is of considerable importance. It has been found that during the formation of benzene the paraffinic constituents undergo isomerization, as will be observed from the analysis of the hexane fraction, produced in another series of runs on a similar charging stock, as given in Table 4.

The recovery of the C_6 paraffins based on C_6 paraffins in the charge amounted to 94%, indicating a small amount of hydrocracking. The distribution of the hexane isomers in the product shows about a 65% approach to equilibrium based on n-hexane concentration. The high extent of branching in the product makes the residual paraffinic material valuable from a motor fuel standpoint.

Toluene Production: Recently a test run was made on the commercial Platforming unit at the Old Dutch Refining Co., Muskegon, Mich., on a Gulf Coast narrow boiling range "pre-toluene" fraction to make a toluene concentrate. The Old Dutch Unit, which has been described previously in some detail[2], comprises a feed preparation column, a naphtha heater, a recycle gas heater, three fixed bed reactors in series with provision for reheating between the reactors, high pressure separator, stabilizer and recycle gas system. The only change made in the unit to prepare it for toluene production was rearrangement of the piping around the feed preparation column so that this column could serve as a product rerun column following the stabilizer. Thus the stabilized Platformate could be rerun to produce as a bottoms product a toluene concentrate, and as an overhead product a light Platformate.

The naphthene content of the feed stock was about 60%, complete conversion of which would result in a heat of reaction more than twice that normally encountered on the Old Dutch feed stock under conventional conditions. For this reason, light Platformate from the rerun column was also used as a recycle feed to the reactors to reduce the endothermicity of the reaction (based on combined feed), thereby greatly reducing the temperature drops in the reactors and making more effective use of the catalyst for a given inlet temperature. The recycle of light Platformate in this manner, while accomplishing the purpose for which it was intended, did result in a somewhat greater extent of hydrocracking and, therefore, a larger volumetric loss than would be experienced with a plant specifically designed for aromatic production.

Another limiting factor on the Old Dutch unit was that the rerun column was inadequate for good separation between light and heavy Platformate. For this reason more toluene appeared in the light Platformate than would be obtained from a column specifically designed to perform the re-running operation.

The Old Dutch catalyst had a total of 155 days of non-regenerative operation prior to processing "pre-toluene" feed stock. Two principal

TABLE 4—Composition of Hexane Fraction Before and After Platforming

Compound, vol.—%	Charge	Product
2,2-dimethylbutane	0.7	4.9
2,3-dimethylbutane	2.6	6.0
2-methylpentane	19.5	30.2
3-methylpentane	19.4	23.1
n-hexane	57.8	35.8
	100.0	100.0

TABLE 5—Charge Stock Analysis, Old Dutch Platforming Unit Toluene Run

Hydrocarbon:	Wt. %
C_7 & C_8 Paraffins	28
C_7 & C_8 Naphthenes	62
Toluene	10
Total	100
Average Molecular Weight	100
Gravity, ° API	57.4
ASTM Distillation, °F.:	
I.B.P.	202
10%	205
50%	208
90%	212
E.P.	224

tests were made, the first at conditions of moderate feed rate, nearly quantitative conversion, and high purity of the aromatic concentrate, the second at conditions of higher charge rate and slightly lower conversion and purity. A charge stock inspection and a summary of the results are given in Tables 5 and 6.

The "heavy Platformate" produced was highly aromatic, 94 and 89 vol. % respectively for the two tests. The distribution of the C_8 aromatics follows closely the equilibrium distribution at the prevailing temperature. The analysis of the non-aromatic portions of the "heavy Platformate" and the "light Platformate" has not been determined, hence the efficiency of dehydrogenation cannot be calculated. However, the observed high molal yields are indicative of an efficiency in excess of 95%.

Production of C_8 Aromatics: Suitable aviation rich mixture blending stocks can be prepared readily by Platforming the "pre-xylene" and "xylene" fractions from straight-run gasolines. Such fractions have been processed in pilot units which are equipped with continuous charge fractionators, simulated "adiabatic" reactors with interheaters, a product recovery system, and a recycle gas system. In one series of runs made on a Coastal C_5-360° F. gasoline, an overhead fraction boiling up to about 220° F. ASTM end-point was removed and the bottoms rerun to prepare "pre-xylene —xylene" fractions for Platforming. In one run the ASTM end-point of this fraction was about 270° F., in the other, about 285° F. These materials were Platformed and the liquid product was fractionated to separate a heavy Platformate on which aviation blending tests were made. In fractionating the product from the lower end-point feed, the intention was to produce a blending stock of high aromatic content even at the expense of yield, and as a result some of the C_8 aromatics produced were distilled into the lower boiling fractions. In the case of the product from the higher end-point feed the intention was to produce a high yield of blending stock at the expense of a somewhat lower purity.

A charge stock analysis is given in Table 7, while a summary of the results is given in Table 8.

It will be noted that in the case of Test 1, the aromatic content of the heavy Platformate was 89%, while in Test 2 the aromatic content was 80%. Both of these materials have suitable F-4 Blending Indices, but in the case of Test 2 the F-3 rating is probably too low for use in 115-145 grade aviation gasoline. The most practical operation in most cases probably lies in between the extremes offered by these two tests.

All tests reported in the present paper have been carried out under conditions of negligible carbon deposition thereby insuring a non-regenerative continuous operation of long duration, similar to that obtained in motor fuel Platforming.

TABLE 6—Results of Toluene Production Run on Old Dutch Platforming Unit

	I			II		
Fresh Feed	**B/D**	**Vol. %**	**Wt. %**	**B/D**	**Vol. %**	**Wt. %**
Test	605	100	100	779	100	100
Separator gas	...	...	8.2	...	...	7.9
Stabilizer gas	...	...	5.8	...	...	6.5
Light Platformate (net)	169	28.0	24.0	185	23.8	22.2
Heavy Platformate	310	51.3	59.0	434	55.7	63.4
			100.0			100.0
Product distribution, wt. % of fresh feed						
Combined gas						
H_2			2.4			2.4
CH_4			0.4			0.5
C_2H_6			1.7			1.7
C_3H_8			4.2			4.1
i-C_4H_{10}			2.4			2.3
n-C_4H_{10}			1.5			1.7
C_5H_{12}			1.2			1.5
C_6H_{14}			0.1			0.1
Benzene			0.1			0.1
			14.0			14.4
Light Platformate						
C_4H_{10}			1.0			1.0
i-C_5H_{12}			2.1			2.7
n-C_5H_{12}			1.2			1.4
C_5 & C_7 P + N*			14.3			12.8
Benzene			0.9			0.9
Toluene			7.5			3.4
			27.0			22.2
Heavy Platformate						
Toluene			48.3			49.9
Ethylbenzene			1.2			1.3
Meta Xylene			3.6			3.9
Para Xylene			1.8			1.3
Ortho Xylene			1.2			1.3
C_7 & C_8 P + N*			2.9			5.7
			59.0			63.4
Heavy Platformate, Composition, Vol. %						
Toluene			81			77
Ethylbenzene			2			2
Meta Xylene			6			6
Para Xylene			3			2
Ortho Xylene			2			2
C_7 & C_8 P + N*			6			11
Gross Molal Yield of Aromatics, % of Theoretical			95			91

* P + N = Paraffins and Naphthenes

Conclusions

The Platforming process is suitable for converting efficiently both C_5 and C_6 ring naphthenes to the corresponding aromatics. Data have been presented to demonstrate that high yields of C_6-C_8 aromatics can be obtained from petroleum fractions to meet the growing demands for these aromatics for aviation fuel blending and in the paint and chemical industries.

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(2) Kastens, M. L. and Sutherland, R. E., *Ind. Eng. Chem.* 42, 582 (1950).
(3) Forziati, A. F., Willingham, C. B., Mair, B. J. and Rossini, F. D., *Petroleum Refiner* 22, 112 (1943), November.

TABLE 7—Charge Stock Analyses, Pilot Plant C_8 Aromatics Production

Test	**I**	**II**
Reactor charge, fraction of C_5—360° F. Gasoline	39–67%	39–74%
Aromatic Content, wt. %		
Toluene	4.1	3.3
C_8 aromatics	8.7	8.0
Higher aromatics	1.6	2.2

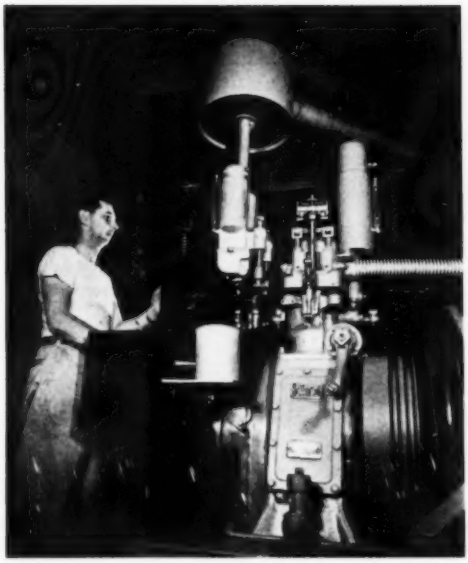
TABLE 8—Results of C_8 Aromatic Production Run on Platforming Pilot Plant

Test	I		II	
Reactor Charge, fraction of C_5-360° F. Gasoline	39–67%		39–74%	
Product distributions, based on reactor charge	**Vol. %**	**Wt. %**	**Vol. %**	**Wt. %**
H_2	...	1.7	...	1.6
CH_4	...	0.5	...	0.5
C_2H_6	...	1.0	...	1.1
C_3H_8	...	2.4	...	2.7
C_4H_{10}	...	3.4	...	4.0
C_5H_{12}	...	3.2	...	2.8
Light Platformate	4.4	4.0	3.7	3.3
Medium Platformate	53.1	54.2	38.3	38.2
Heavy Platformate	26.1	29.6	41.1	45.8
Heavy Platformate Composition, vol. %				
Ethylbenzene		7		10
Meta Xylene		30		25
Para Xylene		13		13
Ortho Xylene		22		14
Higher aromatics		17		18
Paraffins and Naphthenes		11		20
Octane Numbers				
F-3 Clear		100		92.5
+ 4.6 cc. TEL/gal.	S + 0.35 cc. TEL/gal.		S + 0.07 cc. TEL/gal.	
F-4 + 4.6 cc. TEL/gal.	over S + 6 cc. TEL/gal.		over S + 6 cc. TEL/gal.	
AGAC Blending Index*		202		158

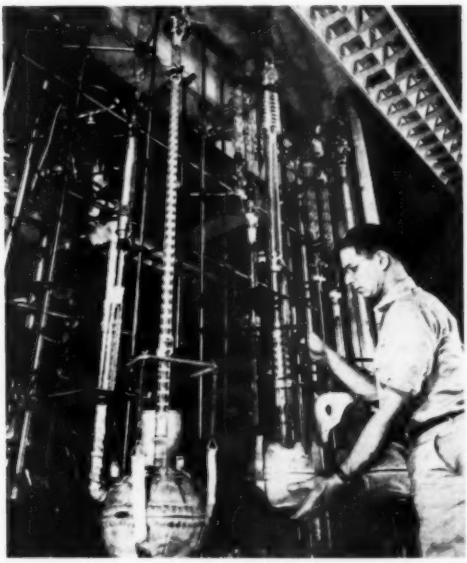
* 20% Heavy Platformate in Alkylate—iso-Pentane Blend.

MAIN BUILDING at Pure Oil Co.'s new Research and Development center at Crystal Lake, Ill., houses administrative offices, library, and physics and chemistry laboratories. Four other buildings are included in the project

Improved Testing, Research Methods Featured in Pure Oil's New Labs



18 ENGINE TEST STANDS are installed in the Automotive Laboratory, each with special mountings or separate foundations to eliminate vibrations



FRACTIONATING EQUIPMENT in the pilot plant bay of the Chemical Engineering Laboratory towers, in some cases 3 stories high

MACHINE SHOP for fabricating and repairing special equipment is an important part of Pure's laboratory, and is well-lighted and well-equipped. Welding and sheet metal shops are also provided

- **Headroom to spare in the pilot plant area—45 ft.**
- **Special photographic department to "record" test results**
- **New rapid test methods for analyzing used oils**
- **Special mountings to eliminate engine vibration**

NEW features in oil company research and product testing facilities are incorporated in Pure Oil Co.'s new research center at Crystal Lake, Ill., which was formally put into operation a few months ago. The improvements include:

A bay with 45 ft. of headroom for pilot plant equipment, with an initial installation of 11 units. Provisions have also been worked out for rapid assembling of pilot plant units and the bay includes a laboratory for testing pilot plant samples.

A special photographic department, for applying new methods developed by the company's staff for taking pictures of engine parts after test runs.

Provision in the chemical laboratory for a system of rapid test methods used in the analysis of used oils and other products, for the benefit of Pure's Technical Service Division.

Special mountings for test engines in the Automotive Laboratory, to eliminate vibrations.

The Research and Development Laboratories include 5 modern red brick buildings in a 140-acre landscaped area at the edge of an an attractive Illinois town, where many of the laboratory staff reside. The buildings include an Administration and Chemistry Building, Automotive Laboratory, Chemical Engineering Laboratory, Storeroom and Supply Center, and Boiler Plant.

The Administration and Chemistry Building has 37,000 sq. ft. of floor space. In addition to the administrative offices, reference library, and clerical staff, it houses the chemistry and physic's sections. The Automotive Laboratory, approximately 175 by 50 ft., is devoted to product performance testing in a battery of engines ranging in size from a small single-cylinder outboard motor to large gasoline and diesel engines. Fuel storage and a general utility distribution center are included in this building.

The Chemical Engineering Laboratory, 224 by 50 ft., includes a 45-ft bay for pilot plant installations. The adjoining main building houses the welding, sheet metal and machine shops on the first floor, and the engineering section's design and drafting shops and the instrument shop on the second floor. The Storeroom and Supply Center, 120 by 35 ft., serves the many and varied needs of the laboratory personnel, such as for chemicals, glassware, scientific apparatus and some mechanical parts. The Boiler Plant has two 200-hp boilers to supply steam for heating the five buildings of the research center and also steam for process work. The Laboratories' water well is also located in this building. Additional data on some features of the Pure Oil laboratories is given below:

Pilot Plant Bay

The pilot plant laboratory comprises an area 150 by 50 ft., a portion having 45 ft. headroom and the balance 30 ft. The initial installation will consist of 11 pilot plants designed to permit development work on the majority of processes used in the company's refineries. Five units are devoted to lubricating oil processing and include a continuous vacuum still, propane deasphalting, phenol solvent extraction, solvent dewaxing and clay contacting. Other equipment includes a combination continuous distillation or thermal cracking unit, light oil treating unit, fixed bed catalytic unit, SO_2 extraction unit, precision fractionation stills, and general purpose batch stills. A laboratory for testing samples originating in the pilot plants is included.

Photography Technique

Photographic records are made of parts from practically all engine tests, such as L-4 and FL-2 using Chevrolet engines, and I-A and I-D using Caterpillar and General Motors diesel engines. Haphazard picture-taking has been eliminated because of the necessity to show not only the extent and quality of deposits but also to permit the comparison of test runs over long periods of time.

Strict control is maintained from the mechanical aspects of exposure, film processing, and print finishing,

DIVISION LEADERS of the Pure Oil Co. Research and Development Laboratories. Standing: Dr. D. C. Bond, Production and Transportation; Dr. M. M. Marisic, Product and Process Research; C. A. Porter, Process Development; B. L. MacKusick, Office and Plant. Seated: W. J. Backoff, Product Development; R. J. Askevold, Analytical Research and Service

to the human aspect of proper illumination, and the right amount and kind of film. Fresh solutions, automatic temperature-controlled tanks, constant densitometer readings, mechanical shutters and audible timers for extended exposures are used to maintain the camera room under the closeat control allowed by the photographic medium.

In the studio, 3200° K. lamps are used in all lighting equipment. Every engine is photographed in color and in black and white. The color film is balanced for this 3200° K. illumination. The lamps burn at a very constant rate over their entire usable life and are all voltage-controlled.

Every engine setup is recorded on a "photo procedure sheet". Data such as subject, background, distance, color, base for subject, lighting arrangement, lens combination (wide angle 5-in., 7-in., 11-in., or 13-in. focal length), size and position of subject on camera ground glass film used, exposure, and miscellaneous notes are recorded for every picture.

The lighting arrangement is recorded to indicate position and proximity of the lamps to the subject. The horizontal plane position is indicated by clock numbers, while the vertical position is indicated by the degrees of a circle. The exact distance from the subject to the lamp is recorded to the nearest inch. If there is a possibility of misunderstanding the camera operator makes a photograph of the subject and lights, all in position to take the finished picture. This photograph of the "dress rehearsal" is then stapled to the procedure sheet.

In the near future it is planned to do the greater part of the photographic work in color, which is becoming easier to control and less expensive. Color is now used on most of the important subjects. In addition to the work on engine parts, photographic records are also made of test equipment of temporary but unusual design. Lantern slides are prepared for papers and general photographic work is done for the various main divisions of the company. Regarding the procedure for photographing parts, in engine test work, a report of the company states:

"The only satisfactory method of recording results of engine tests for comparison over a period of time is by a photographic history. Many government specifications require photographic evidence of test results and this calls for specialized photographic equipment and techniques.

Parts taken from engine runs and containing deposits, cannot be stored except under special conditions and at considerable expense. A large amount of space is required for storage of such parts and the area must be maintained under conditions of constant temperature and low humidity. Parts so stored represent a considerable financial investment. The greater portion of these costs can be saved by photographing the parts, cleaning them and re-using the salvageable parts.

20-Minute Sample Test

There has been a need, a company report stated, for some rapid means of revealing engine condition, especially for the benefit of automotive fleet operators desiring proper lubrication and maintenance. As a result of this need the "Pure Sure System of Used Oil Analysis" was evolved. Since speed is essential if preventive measures are to be employed, this factor was important in the development of the system. Through the use of mass production techniques it is possible to test a sample completely in only 20 minutes when the system is operating at full capacity.

A system of this type must necessarily be economical since a high cost would prohibit wide application, thus curtailing its usefulness to lubrication engineers. In addition to the speed inherent in the system, another factor contributing to the economy is the elimination of the need for the highly skilled operators required by the conventional analytical methods.

WILLIAM B. ROSS,
Director of Research

DR. L. M. HENDERSON,
Technical Service Director

LIBRARY FACILITIES are an essential research tool. Pure's library, located in the main building, contains almost 3000 books and sets of reference material, plus 125 regularly issued magazines

This is made possible by the simplicity of the methods and the use of automatic controls.

Since it was originally felt that the indication of trends would be of greater significance than absolute values, the system was not initially aimed to give the high precision of the conventional procedures for used oil testing. However, experience has shown that the system as presently employed does approach such precision. The results are comparable in significance to those obtained by ASTM methods for oil testing.

Values provided by the Pure rapid analysis system include: viscosity dilution, mineral oil, oil oxidation products, fuel deterioration products, extraneous contaminants, water remaining detergency.

Viscosity is determined by means of a torsion-type viscometer. By using a 16-place turntable in a constant temperature bath for samples, one determination can be completed every 5 minutes.

Dilution of the oil by fuel is characterized by a marked decrease in viscosity and is measured quantitatively by a vacuum distillation. The system employs specially built equipment for such a procedure, which makes the operation completely dependent on electronic controls after the flask has been charged. Water content is also estimated in this step.

The various classes of contaminants in the oil are separated by centrifuging with a succession of selective solvents. The insolubles which remain after these extractions are examined microscopically to detect and classify extraneous contaminants.

This rapid system for used oil analysis has proved to be a valuable asset to technical representatives of Pure Oil Co. as an index of engine condition and as a clue to misapplication of lubricants. It also gives warning of impending engine failure, and is thus of particular value for proper preventive maintenance and correct lubrication in fleet operation. The need for costly overhaul is thereby often eliminated by less expensive corrective measures.

Automotive Laboratory

The Automotive Laboratory has 10 full-scale, 3 single-cylinder and 5 CFR engine stands. The beds of all multi-cylinder engines are mounted independently of the floor and foundations of the buildings. The CFR engines are spring-mounted in order to eliminate the vibration of the engine operations from the rest of the building, since these engines are mounted on the first floor with a full basement beneath them, and to use the same type of support as that used for multi-cylinder engines was not feasible.

CHARLES M. RIDGEWAY, Manager

Six of the full-scale test stands are used for the conventional heavy-duty, standardized oil tests, such as the L-4, FL-2, I-A and I-D. One full-scale stand is devoted to gasoline and lubricating oil research for new high compression ratio engines. The General Motors research engine, which is capable of operation at 8:1, 10:1 and 12:1 compression ratios, is now being tested. One full-scale test stand is for automatic transmission fluid tests using a Buick engine equipped with dynaflow transmission. One test stand is used for measuring propeller shaft horsepower of outboard motors. This work is an endeavor to produce improved lubricants and fuels for two-cycle gasoline engines.

Two single-cylinder test stands are equipped with COT engines for evaluating high output reciprocating engine aircraft lubricants. These same engines can be operated as diesel engines by changing from manifold to direct cylinder injection without any other changes in equipment. The remaining single-cylinder engine stand is equipped with a CFR engine modified to be operated at variable speed and load under conditions that allow road-test type fuel evaluations.

Four CFR knock test engines are used for gasoline antiknock quality tests and one engine is used for diesel fuel ignition quality tests. Part of the Automotive Laboratory is also used for engine rebuilding, engine measurements and necessary services for engine test work.

COMPRESSOR LUBRICANTS—

—and How to Select the Right Ones

The lubrication requirements of different type compressors in a wide range of services were studied in the laboratory of a large oil company. Different oils, including the new types, were tested for their characteristics of importance in compressor lubrication. The resulting data provided a basis for the selection of commercial compressor lubricants which has been in successful use for several years. Factors to consider in the choice of lubricants where petroleum and other gases are compressed are discussed briefly, also the lubrication needs of special types of compressors.

By K. L. HOLLISTER
Technical and Research Division
The Texas Co., New York

RIGHT after the war, a comprehensive study of compressor lubrication was made, particularly from the standpoint of evaluating the newer type oils as compressor lubricants. In making this study, first, the properties of the various oils were determined in The Texas Co. Laboratories, at Beacon, N. Y.; second, the requirements of different type compressors were examined and, third, the best oil for each type compressor was selected. For the past several years results of this investigation have been applied commercially with considerable success.

As a basis for the evaluation of the newer type lubricants, five commercial oils were chosen, all having a viscosity of approximately 300 Saybolt Universal sec. at 100°F. These five oils are defined below and their physical tests are shown in Table 1:

1—A straight naphthene oil.

2—The same naphthene oil inhibited against rust and oxidation.

3—The same naphthene oil compounded with 3% fatty oil.

4—A detergent heavy-duty oil.

5—A straight paraffin-base oil.

Having selected the five oils, they were next subjected to a gamut of physical and chemical tests designed to measure characteristics of interest from the standpoint of compressor lubrication. The first consideration was of course the most important function of a lubricant, namely, to reduce friction and prevent wear. The factors which are of interest in this connection are viscosity, evaporation, film strength and water reaction.

It will be noted from Table 2 that, as would be expected, since all oils have the same viscosity at 100°F., the naphthene oils are less viscous at 210°F. Calculations show, however, using the *ZN/P* formula applied to a conventional compressor, that the difference in viscosity at 210°F. between the oils is not sufficient to affect appreciably the coefficient of friction or the film thickness.

The rate of evaporation of the various oils at 250°F. is also shown in Table 2 and while there is a difference between the oils, even in the case of the most volatile oil, in an average compressor the evaporation is less than 5% of the total oil consumed. In other words, over 95% of the oil is removed from the cylinder walls by mechanical action, and any difference in the evaporation characteristics of the oils is of no concern at the comparatively low cylinder wall temperature.

The film-strength values as measured on the Almen machine are also given in Table 2. The compounded oil will give slightly more protection against scuffing while the detergent oil is considerably better in this respect. In a compressor, however, most wear is due to contamination against which extreme pressure agents offer no protection and, therefore, only in rare cases will a high film strength oil be needed.

Water affects the lubrication of an air compressor in two ways. If it condenses on the cylinder walls it will interfere with lubrication and cause wear. If it is present in any portion of the system, rusting may occur. Rusting in a compressed air system cannot be tolerated, since the rust particles may reach the rubbing surface of either the compressor or the pneumatically operated machines.

It will be noted from Table 3 that the five oils were subjected to the ASTM Rusting Test and the Humidity Cabinet Test and their rust protection qualities compared. It was found that the rust and oxidation inhibited oil and the detergent oil offer the best protection. It can be concluded, therefore, that if good water separation is desired, as is the usual case, the inhibited oil would be preferred. If, on the other hand, water is actually condensing on the cylinder walls, then an emulsifiable lubricant is needed and either the detergent or the compounded oil should be used.

To determine where condensation occurs in a compressed air system, the relative humidity has been calculated at various points. From Table 4, it will be noted that even though air having a relative humidity of 100% is admitted at the air intake of the compressor, the only place that the air becomes saturated in the entire compressed air system is in the after-cooler and in the distribution lines. Thus, an emulsifiable oil is seldom needed in compressor operation, except where: 1—the compressor cylinder jacket cooling water is considerably below atmospheric temperature, or 2—inter-cooling is insufficient and superheated air

Meet the Author

Kenneth Lee Hollister graduated in mechanical engineering from the University of Michigan and in 1926 joined the Ingersoll-Rand Co. He served in the diesel engine and compressor departments until 1929, when he became technical assistant to the salesmanager in New York. He joined the Technical and Research Division of The Texas Co. in 1932, where he has specialized in internal combustion engine fuels and lubricants, and general machinery lubrication. He became assistant to the Division manager in 1947.

TABLE 1—Identification Tests

Oils	API Grav. ASTM D 287	Sapon. No. ASTM D 94	Ash % ASTM D 482
Inhibited naphthene	23.1	0.03	0.00
Straight naphthene	23.1	0.03	0.00
Compounded naphthene	23.3	6.50	0.01
Detergent paraffin	27.5	1.60	0.24
Straight paraffin	29.3	0.03	0.00

TABLE 2—Wear Factors

Oils	Viscosity Saybolt Universal sec. at 210° F., ASTM D 88	Evap., oz./sq. ft. /hr. at 250° F.	Almen Value, psi
Inhibited naphthene	48	0.020	4,000
Straight naphthene	48	0.016	4,000
Compounded naphthene	48	0.020	5,000
Detergent paraffin	54	0.006	10,000
Straight paraffin	54	0.003	4,000

reaches the higher stage cylinders.

The biggest problem met in compressor lubrication is the operator, who, on observing wear, increases the amount of oil fed to the compressor which results in excessive carbonization at the discharge valves. Wear in a compressor is usually due to contamination of the air and seldom to insufficient lubrication. Therefore an excess of oil should seldom be fed to the compressor even as a temporary expedient.

However, even in the best regulated compressors, carbon may deposit on discharge valves. Therefore, conditions under which this carbon forms deserve consideration. Table 5 shows the temperatures at the discharge valve at various pressures, and it will be noted that the temperatures may vary from 200 to 500°F. At the discharge valves the lubricant therefore lies on a flat, often horizontal, surface exposed to high temperatures for a considerable length of time. This results in the formation of carbon, the amount and nature of which depends on the type of oil, the compression temperature, and the design of the valve.

In order to select a laboratory test which would correlate with the tendency of the different oils to form carbon on the discharge valves, the oils were listed as in Table 6, based on their service performance. It will be noted that neither the oxidation resistance nor the carbon residue tests evaluated the oils in order of service rating. Consequently, it was necessary to devise a special test in which the oil was exposed on a flat plate in a thin film for 24 hours at various temperatures and the residue determined. It will be noted that this test, as would be expected, checked very well with service experience. It also will be noted that the carbon-forming tendency also varied with the rate of evaporation —the oils which evaporate quickly leave the least carbon.

It will also be noted, as would be expected, that the flash point correlated with the rate of evaporation and the carbon formation. This is of interest in connection with air receiver fires and, on checking several authorities, it was found there was general agreement that, to prevent such occurrences, an oil having the least tendency to form carbon should be used, and that flash point should not be given consideration, since it is a well established fact that flash point has no relation to autogenous ignition temperature. Incidentally, the ASTM autogenous ignition temperature of the five oils was in each case close to 700°F. Table 7 gives the thin film residue test on two of the oils, from which it will be noted that, regardless of temperature, the naphthene oil leaves the least residue. Of interest is the fact that at the lower temperatures the deposit was wet and soft and at the higher temperatures dry and hard.

The low-temperature characteristics are of importance, for example, in portable air compressors and refrigeration machines. In the latter, the pour point which determines the temperature at which wax may form is an important consideration. In portable air compressors, the temperature at which the oil reaches a certain viscosity, such as 30,000 Saybolt Universal sec., is the major consideration, and it will be noted from Table 8 that the oils with the higher viscosity index have the lower satisfactory starting temperature.

Selecting the Lubricant

Putting the above information to practical use, let us first consider the conventional single or two-stage air compressor. Under normal operating conditions, any good grade power plant or general industrial oil will satisfactorily lubricate the air compressor. Under special conditions, some of which will be enumerated, the lubricant must be more carefully selected.

Should carbon deposits form on the discharge valve, then either a naphthenic or a detergent oil should be selected. Normally, the naphthenic oils are superior; however, there are designs where the detergent oils have proved most satisfactory. Apparently, the rate of flow of the oil across the discharge valve is the determining factor. If the oil lies stagnant, a straight naphthenic oil is likely to be best. If the oil flows across the valve surface, then the detergent action of the heavy-duty oils can be used to advantage. If rust protection is needed, then the rust and oxidation inhibited oils should be used. If condensation of water on the cylinder walls is causing wear, then either the detergent or the compounded oil is preferred. In the rare case where scuffing occurs, the high film strength of the detergent oils can be used to advantage. Where low temperatures are encountered, the higher viscosity index paraffin oils should be selected. If oil-free air is needed as in the case of food processing or diving operations, then a straight mineral nonvolatile paraffin-base oil of fairly high viscosity is needed.

For high-pressure air compressors heavier oils are usually recommended, not only because of the increased compression pressure but often because of the necessity of keeping the stuffing box well sealed. Since the heavier naphthenic oils are rather difficult to manage at atmospheric temperatures, where heavy oils are required, paraffin-base lubricants are generally used. Such oils are also preferred because of their greater resistance to oxidation, which is more prone to occur in high-pressure machines where there is a higher concentration of oxygen. Should valve

TABLE 3—Water Reaction

Oils	Antirust Rating, ASTM D 665	Humidity Cabinet Rating, AN-H-31	Emulsifying Tendency
Inhibited naphthene	1	2	Nonemulsifying
Detergent paraffin	2	1	Emulsifiable
Compounded naphthene	3	3	Emulsifiable
Straight paraffin	4	5	Nonemulsifying
Straight naphthene	5	4	Nonemulsifying

TABLE 4—Condition of Air Passing Through 100-Lb. Single-Stage Compressor

	Gage Pressure, psi	Temp., deg. Fahr.	Relative Humidity, %
Atmosphere	0	65	100
Beginning of compression	0	75	74
15-lb. compressor	15	172	12
End of compression	100	485	>1
After-cooler at 138° F.	100	138	100
Leaving after-cooler	100	80	100+
End of transmission pipe	97	65	100+
Tool exhaust	0	35	43

TABLE 5—Air Compressor Discharge Temperature

Compression Gage Pressure, psi.	Approximate Compression Temperature, deg. Fahr. Single-Stage	Two-Stage
50	350	210
100	500	250
200	---	310
300	---	350

TABLE 6—Carbon Formation Indicators

	Thin Film Residue, % at 350° F.	Evaporation, oz. per sq. ft. per hr. at 350° F.	Flash Point, deg. Fahr., ASTM D 92	Carbon Residue, per cent, ASTM D 189	Oxidation Resistance Rating
Inhibited naphthene	5	0.026	385	0.02	1
Straight naphthene	9	0.031	380	0.01	4
Compounded naphthene	10	0.031	395	0.03	5
Detergent paraffin	16	0.010	435	0.37	2
Straight paraffin	22	0.006	440	0.01	3

TABLE 7—Thin Film Residue Test, Typical Results

Temperature, deg. Fahr.	Thin Film Residue, per cent Straight Naphthene Oil	Straight Paraffin Oil
250	14	37
350	9	22
450	6	13

TABLE 8—Low-Temperature Characteristics

Oils	Temperature for 30,000 Saybolt Universal sec., deg. Fahr. Viscosity	Viscosity Index, ASTM D 567	Pour Point, deg. Fahr., ASTM D 97
Inhibited naphthene	+ 10	36	— 20
Straight naphthene	+ 10	36	— 20
Compounded naphthene	+ 7	46	— 20
Detergent paraffin	+ 4	90	— 5
Straight paraffin	+ 0	100	— 5

deposits occur, however, the naphthenic oils should be used. In this connection, as indicated in Table 9, it is interesting to note the extent that viscosity increases under pressure.

Where gases other than air are compressed, straight mineral oils should normally be used, at least with such gases as carbon dioxide, nitrous-oxide, hydrogen, freon, and ammonia. Straight mineral oils are also used with hydrogen sulfide and sulfur dioxide. However, where such gases containing sulfur are used, extreme care must be taken to keep the oil dry and avoid entrance of water into the system. Compressors handling oxygen and chlorine should be built so that no lubrication is required.

Where petroleum gases are compressed, there are several factors that must be taken into consideration, such as the absorption of gas by the lubricant. Therefore, normally when compressing petroleum gases the oil viscosity should be about one grade heavier than when compressing air. If the gas contains liquid petroleum, such as entrained gasoline, compounded oils are often used to resist the washing effect. Where unstable refinery gases are compressed, the detergent oils have been found most effective in preventing gum and lacquer deposits. Where petroleum gases are compressed to high pressures, steam cylinder oils are recommended.

Air compressors are used in connection with diesel engine applications. For the starting air compressor previous comments apply. For the injection air compressor, which is usually an integral part of air injection diesel engines, compounded oils are often used. Here the problem is the prolongation of the life of the intercooler made of copper tubes through which the air passes at high velocity. Rapid erosion of these tubes occurs due to the combination of the high velocity of any foreign particles in the air stream. Compounded oils seem to resist this erosion, while the detergent oils, on the other hand, have a scoring effect and tend to shorten the life of the inter-cooler tubes.

The third application of air compressors in diesel engine operation is in the superchargers or the scavenger blowers which furnish air directly to the engine. These blowers operate at high speed and require a light oil for bearing lubrication. Often the same oil used in the diesel engine is applied to the supercharger or blower bearings. However, in most cases, a lighter oil fed from an independent lubrication system is preferred.

Compressors are, of course, the most essential element in refrigeration systems. With rare exceptions, the naphthenic oils having low pour points and good water separating characteristics are offered.

Rotary positive displacement compressors, such as the vane type, require heavier oils to seal the rubbing surfaces and prevent wear. The hot plate effect is absent in these machines, and consequently, paraffin base oils, often containing rust and oxidation inhibitors, are recommended.

For centrifugal blowers, the only lubricant required is for the bearings which are usually grease lubricated. Only highest quality antifriction bearing lubricants are recommended, as this has proved to be rather severe service.

The bearings are the principal elements requiring lubrication on the axial flow compressor, and a light viscosity rust and oxidation inhibited oil is preferred.

A vacuum pump is essentially a compressor operating at an intake pressure below atmospheric and a discharge pressure near atmospheric. The paraffin base oils are generally recommended for vacuum pumps for, being least volatile, their consumption will be lowest. There is also an absence of any heat condition which would require the naphthenic type oils. For high-vacuum pumps, the oil should be most carefully selected, a narrow cut paraffin stock being required. In many applications a considerable amount of water enters at the vacuum pump intake and at the same time the amount of oil leaving the vacuum pump at the discharge valve is considerable. This mixture of oil and water is usually removed from the air by a separator which is an integral part of the vacuum pump. From this separator, the water is drained off and the oil is returned to the compressor lubrication system. It is, therefore, highly important that the oil have good water-separating characteristics. Where the vacuum pump is handling air or other gases containing foreign matter, as in the case in pigment industries, detergent oils have proved satisfactory in preventing deposit formation.

Considerable care should be used in selecting a lubricant for a compressor. However, the problems involved are well recognized and their solutions well known. If the lubrication recommendations of a qualified lubrication engineer are followed, satisfactory performance will be assured.

TABLE 9—Effect of Pressure on Viscosity of a Typical Heavy Compressor Oil[a]

Gage Pressure, psi.	Saybolt Universal Viscosity at 210° F., sec. (Calculated)
0	100
5,000	170
10,000	240
15,000	310

[a] Based on Table 3 of "Viscosity of Lubricants Under High Pressure," by Hersey and Hopkins, *Mechanical Engineering*, December, 1945, p. 822.

Acknowledgment

Presented before the American Society of Lubrication Engineers, Jan. 25, 1950, and before Section U-VI, Technical Committee B of ASTM Committee D-2 on Petroleum Products and Lubricants, Washington, Feb. 21, 1950. Published in *Lubrication Engineering*, August, 1950.

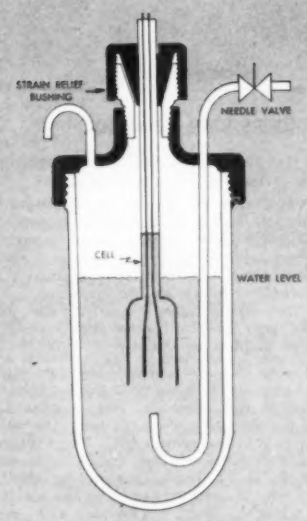


FIG. 1 – ACID CORROSION STOPPED

CORROSION PROBLEM SOLVED

PROBLEM: To prevent the leakage of acid bearing materials from acid treating units through refrigeration coolers or exchangers.

CONDITIONS: One specific unit handling HCL in the vapor state, the acid leakage was into the propane refrigerant. This caused rapid corrosion of the propane compressors.

SOLUTION: (See Fig. 1) A conductivity recorder was chosen as a means of detecting leakage immediately. The cell was made up using a glass container (an old vapor-proof light fixture bowl) half-filled with distilled water. A sample tube running to near the bottom of this container brings in a very small bleed from the exchanger propane outlet line. The conductivity cell is immersed in the distilled water and connected to the recorder. Any leakage of acid into the propane causes the water to become more conductive immediately, and shows on the recorder. The recorder is equipped with an alarm switch. This one installation is credited with saving thousands of dollars in repairs.

GADGETEERING

With Process Control Instruments

Gadget making has been developed to an especially fine art by petroleum processing men, and particularly by instrument men. The best instrument men today are born "Rube Goldberg" tinkerers. Some of their brain-children take the form of complex home-made contraptions assembled from scrap material around the plant. Others represent relatively simple shop-built accessories, unusual applications for standard commercial equipment, and slight modifications of standard equipment to fill new uses. Some examples of this latter type of gadgeteering are presented on these pages.

They have been taken from a paper entitled "Gadgeteering" by J. M. Jones, Jr., foreman, instrument department, The Texas Co., Port Arthur, Texas, and delivered at the Fourth Annual Short Course on Instrumentation for the Process Industries at Texas A&M College, in October, 1949. The complete paper by Mr. Jones, as well as others from the short course, have been given limited distribution in Texas A&M's Bulletin No. 120, published recently. This material on gadgeteering has been made available to PETROLEUM PROCESSING through the courtesy of the author and Texas A&M College.

CONTROL OF CRACKING UNIT BLOWERS

PROBLEM: To regulate the speed of turbine-driven blowers furnishing carrier air in catalytic cracking units.

CONDITIONS: Normally, the control consisted of an orifice and flow controller in the air line controlling the steam flow to the turbine. The turbine also was equipped with a circulating oil governor which was set up to prevent overspeeding of the turbo-blower in case anything went wrong with the flow control. This governor consisted of a gear or vane-type oil pump driven from the turbine shaft, which took suction on an oil sump and forced this oil under the piston which actuated the steam governor valve. An adjustable orifice in a by-pass from the pump discharge to the sump was set by hand to give whatever maximum speed was desired. Since the turbine normally operated at a speed slightly below the speed for which the governor was set, the governor had a tendency to foul up and not operate when called upon to do so.

SOLUTION: (No drawing) The manually adjustable orifice in the governor oil system was replaced with a small diaphragm control valve with needle seated trim. An adjustable stop was installed on the diaphragm case to limit the travel of the stem. The flow controller then was disconnected from the steam valve and connected to this valve. In setting up the control system, the stop on top of the diaphragm valve was screwed pretty well down and the turbine started. With no air pressure on the diaphragm the stop then was backed out until the turbine reached its maximum safe operating speed. The flow control then was cut in and it operated the turbo-blower to maintain the desired flow by varying the position of the diaphragm-operated governor oil by-pass valve. This method gives very satisfactory performance and is used on turbines with this type governor in preference to other methods of control.

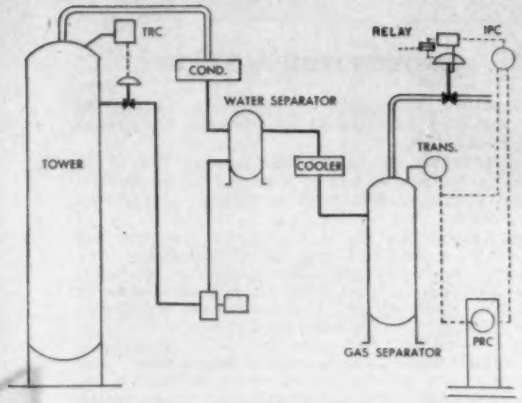


FIG. 2 – PIPE STILL CONTROL

PIPE STILL CONTROL

PROBLEM: To obtain closer control of pressure and temperature on a pipe still-atmospheric tower.

CONDITIONS: Pressure controller has its valve on gas separator drum gas outlet with pressure tap in top of drum. Control valve is large with large capacity diaphragm. Thermocouple in tower top section controls reflux flow back to tower. After unit was started, it was impossible to hold temperature or pressure. As one would swing, other would follow. Analysis showed chief cause was time lags due to transmission and capacity lags on the large diaphragm chamber.

SOLUTION: (See Fig. 2) A remote set controller was installed at the gas outlet valve, with the pressure transmitter connected to this controller and also the original controller at the main panel. Output from the panel instrument was tied into the remote set. Panel instrument then served as a remote set unit and could have been replaced by a Moore or Taylor remote set device. A pressure record was desired, however, so the existing installation was retained. Next, a 1-to-1 air relay was put in between the valve positioner and the diaphragm. Large ports in the relay practically eliminated diaphragm lags.

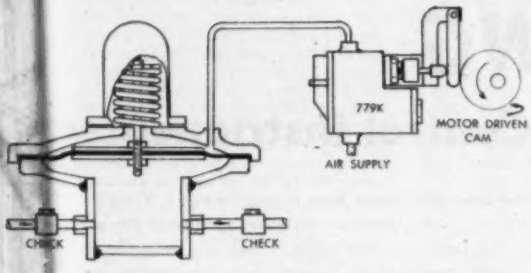


FIG. 3 – WASTE WATER SAMPLING PUMP

pH OF WASTE WATER

PROBLEM: To obtain longer service life from a waste water sampling pump.

CONDITIONS: A pH recorder was being used on refinery effluent water. Water entered a suction pit where it was picked up by large, low head centrifugal pumps and discharged through a siphon-type discharge line. Because of this type discharge, there was not enough head to lift the water into the electrode housing, thus requiring a small sampling pump. Due to wide changes from acid to caustic waters, no pump stood up because of the high turbulence in a rotary or a centrifugal.

SOLUTION: (See Fig. 3) A freak pump was made using an old Foxboro diaphragm head from a motor valve, installing a reservoir on it with inlet and outlet check valves, and actuating the device by mounting a Fisher 779K level pilot driven by a cam on an old Brown recording potentiometer motor. The motor turned the cam at 16 to 17 rpm, and the pump made a like number of strokes/minute.

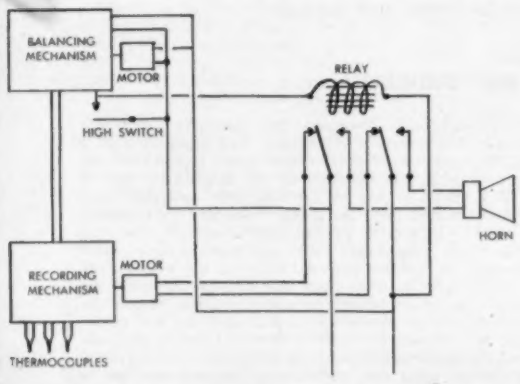


FIG. 4 – ELECTRONIC FOAM ALARM

FOAMING ALARM

PROBLEM: To sound an alarm should any one of a number of process kettles start foaming.

CONDITIONS: Due to number of kettles and space limitations for mounting instruments, separate alarms would have required excessive equipment and been expensive to install. Investigation revealed that if a thermocouple were installed above normal liquid level in the kettle, any foaming would immerse the T/C and show an immediate temperature increase.

SOLUTION: (See Fig. 4) T/C's in each kettle, about one foot above normal liquid level, were connected to an 8-point L&N Speedomax electronic temperature recorder. A high temperature alarm switch, set to operate at any rise above a predetermined point, was installed in the Speedomax. A relay was wired into the 115-volt circuit of the instrument, arranged so that when the switch operated, the chart and switching motor stopped and the alarm sounded. Since the switching motor was stopped but the electronic temperature instrument and pen drive were still active, kettle temperature indication continued. When this temperature dropped below the alarm point again, the instrument returned to normal operation.

GASOMETER SAFETY CONTROL

PROBLEM: To record the height of the floating bell in a flue-gas gasometer and to protect gasometer seal against blowing.

CONDITIONS: Flue-gas generator operates continuously. A limited amount of flue gas is returned to gasometer from other sources. Gasometer in a hazardous area, making air operation desirable.

SOLUTION: (See Fig. 5) A differential drum of pipe and boiler plate is mounted near the bottom of the gasometer. Cable connects the larger drum to the gasometer bell via pulleys at top of framework. Another cable on the smaller drum is counterweighted. A floating nut on fine thread at end of drum axle operates—by bell crank—a Mason Neilan 93D liquid level pilot connected to a recording pressure gage in the control room. To prevent overfilling the gasometer, a normally closed diaphragm valve is installed in the supply line from the generator and a normally open valve in a line to the atmosphere. A Taylor 88S52 3-way pilot valve is connected to the output of the 93D pilot. As gasometer nears maximum capacity, supply valve closes and vent valve opens. Another 3-way pilot, also tied in to the 93D, is adjusted to sound an alarm in the control room.

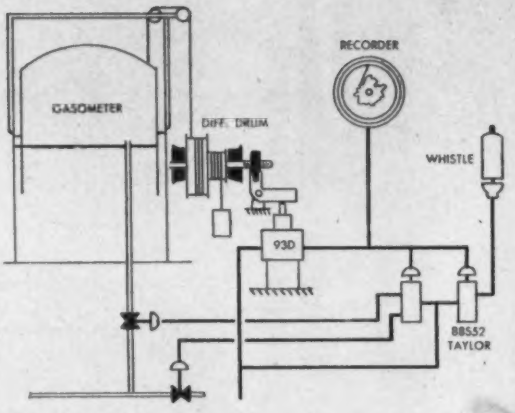


FIG 5—GASOMETER SAFETY CONTROL

COMPRESSOR CONTROL

PROBLEM: To provide a safety shut-off for an ammonia compressor.

CONDITIONS: A steam-driven compressor, with intake on a suction trap, was to be shut down by a level controller in the trap if liquid ammonia rose to a level where it might carry over. Through a specification error, the compressor steam end was good for only 125 psi. Steam supply was 150 psi.

SOLUTION: (See Fig. 6) A pressure-reducing valve could have been used, but the compressor already had a diaphragm valve. Therefore, a pressure controller was installed with its tap between the diaphragm valve and the steam inlet. Pressure controller air supply was piped through a three-way pilot valve. The level controller operated the pilot, and the pressure controller operated the diaphragm valve. The pressure controller then supplied steam at 120 psi. If liquid level rises, the pilot cuts off supply air to the pressure controller, closing the diaphragm valve to shut down the compressor.

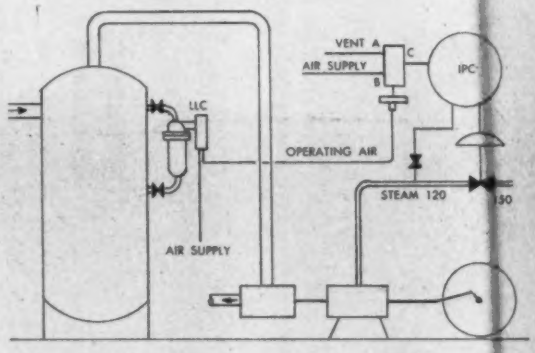


FIG. 6—COMPRESSOR SHUT-OFF

CAN FILLER LEVEL CONTROL

PROBLEM: To maintain a safe liquid level in the reservoir of a Sprague-Sells one-quart can filler on a can-filling line.

CONDITIONS: Oil flowed from an overhead tank to the reservoir through a lever-operated gate valve operated manual by the employe. The machine shut off automatically if it ran out of cans or if a faulty can jammed the filler itself or the sealing equipment. The employe then had to shut off oil flow quickly to avoid a spill. In addition, he had to spend a great deal of time maintaining correct level in the reservoir. The reservoir revolved, making level measurement a problem.

SOLUTION: (See Fig. 7) A displacement-type level controller was suspended so the displacer was inside the reservoir. A stilling sleeve around the float prevented its being buffeted about. A diaphragm valve was put in the oil line. In addition, a special air manifold was arranged so that the normally closed valve could be opened manually for draining the flushing the machine.

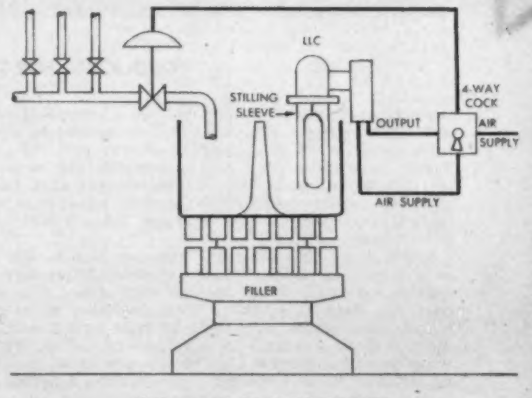


FIG. 7—SAFE LIQUID LEVEL

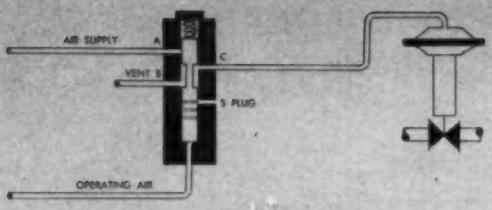


FIG. 8

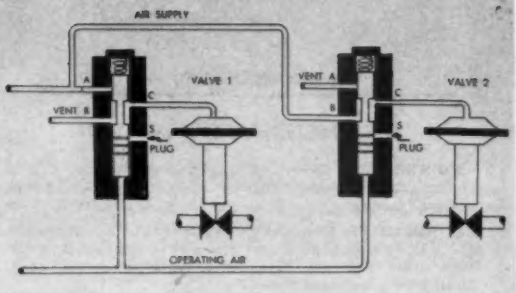


FIG. 9

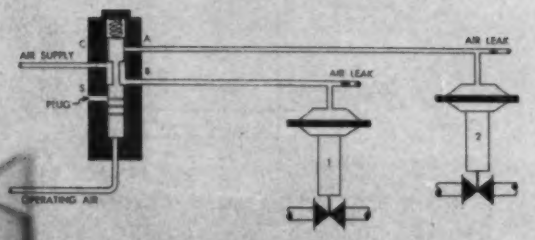


FIG. 10

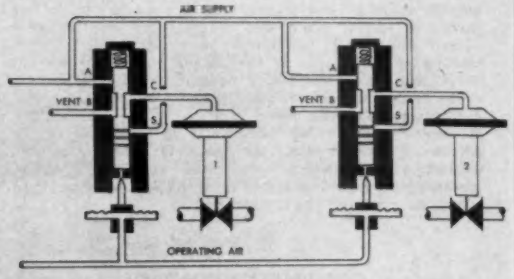


FIG. 11

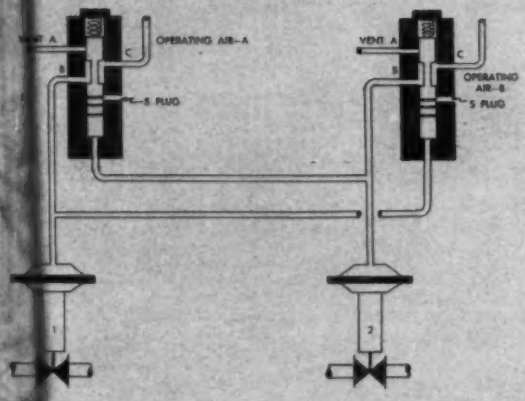


FIG. 12

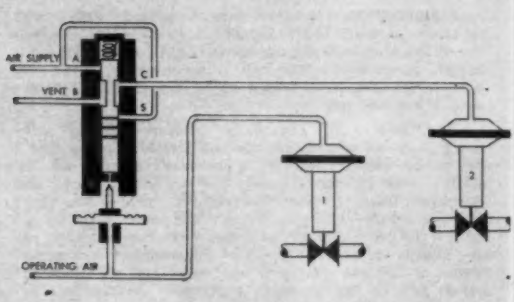


FIG. 13

"ODD JOBS" FOR THREE-WAY PILOT VALVES

An interesting little gadget that has a number of uses and, by very slight alterations, can be applied to other uses is the No. 88S51 or 88S52 three-way pilot valve of Taylor Instrument Cos. The two models are identical in construction except that the 51 operates at a fixed initiating pressure while the 52 may be adjusted to operate at any pressure from 1 to 25 psi. Some typical "odd jobs" follow:

In Fig. 8, the three-way pilot valve has been hooked up as a volume amplifier. When operating air pressure is applied, supply air passes through ports *A* and *C* to operate the diaphragm valve. When operating air is removed, the diagram valve vents through ports *C* and *B*.

Fig. 9 shows a selector device where two of the 88S51 (fixed initiating pressure) valves are used to accomplish the inflation of one diaphragm valve and the deflation of another, using the same source of operating air. In this operation when operating air is applied, supply air passes through ports *A* and *C* to inflate the diaphragm of Valve No. 1 and at the same time diaphragm of Valve No. 2 vents through ports *C* and *A*.

In Fig. 10, a single 88S51 is used to operate two valves. In this scheme a leak must be installed on each of the valves.

Fig. 11 shows two 88S52 pilots in a sequential hook-up so that two diaphragm valves may be operated in sequence from a single source of operating pressure.

Another application of adjustable pilots is shown in Fig. 12. Two of the 88S52 valves are used with two diaphragm valves and two operating sources so either one may be operated first while the other is locked out. Or, as indicated in Fig. 13, the pilot is used to interlock two diaphragm valves so the second cannot open until the first has opened.

Effect of Volatility on Evaporation Loss in Fuel Tank and Carburetor

Of the various factors of engine performance affected by motor fuel volatility, three are likely to be influenced by the trend toward fuels of higher vapor pressure and higher 90% point; vapor lock, fuel tank and carburetor evaporation losses, and warm-up. Modest increases can be made in the vapor pressure of gasolines in spring, fall and winter, with a sufficient margin of safety from vapor lock. New data is presented showing the significance of evaporation losses in postwar cars, which could be minimized by specific engine and fuel system design changes.

*From a Report**
By W. M. HOLADAY and D. P. HEATH
Socony-Vacuum Laboratories

UNLIKE anti-knock quality of motor fuels, which affects only detonation and pre-ignition, volatility influences a number of criteria of engine performance. These are listed as follows under the fuel volatility parameter by which they are primarily affected:

INITIAL VOLATILITY
1. Vapor Lock
2. Starting
3. Evaporation Loss

AVERAGE VOLATILITY
4. Warm-up
5. Stalling
6. Acceleration

FINAL VOLATILITY
7. Fuel Economy
8. Crankcase Oil Dilution
9. Engine Cleanliness

1—Vapor Lock: While for normal commercial purposes Reid Vapor Pressure is taken as the sole criterion indicating the tendency of a fuel to vapor lock, for research and engineering purposes a more representative criterion is required. In meeting the liquid requirement of modern passenger car engines, the pump is capable at any time of pumping 30 to 50 volumes of vapor in addition to the liquid. Obviously, then, some measure of conditions required for a fuel to form 30 to 50 volumes of vapor per volume of liquid would be a good criterion of vapor locking tendency.

The Reid Vapor Pressure method does not provide the proper criterion because it measures the vapor pressure of a fuel under conditions where there are only four times as much vapor as liquid. Consequently, a correlation for estimating the temperature at which a fuel will form 45 volumes of vapor and one of liquid under atmospheric pressure in a closed system was developed by Aldrich, Barber and Robertson.(1) This correlation utilizes both the RVP and the ASTM distillation curve of the fuel.

Limited data from surveys of the vapor-locking characteristics of postwar cars indicates that the early postwar models did not have the same factor of safety from vapor locking as prewar cars. Later model postwar cars have been more severely streamlined, and have had a general tendency toward higher underhood temperatures and, consequently, increased vapor locking tendencies.

Available data shows that, with present gasolines, the margin of safety from vapor lock is smallest in summer and largest in winter. This condition indicates that, where refining operations permit, modest increases can be made in vapor pressures in spring, fall and winter seasons. In addition, a reduction in the tendency of automobiles to vapor lock would aid in the conservation of our petroleum resources.

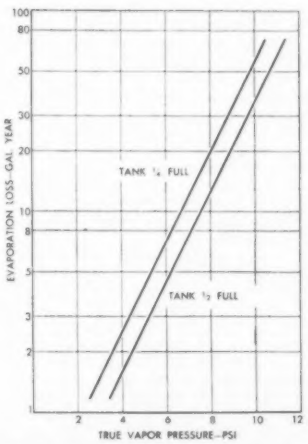


FIG. 1—Evaporation losses from passenger car gasoline tanks

2—Starting: Fuel volatility is of secondary importance in engine starting. Correlations relating the temperature of the 10% evaporated point and the slope of the curve at the 10% point of the ASTM distillation to the lowest temperature for satisfactory starting, and for possible starting for engines in good mechanical condition are given in the CRC Handbook.(2) These relationships indicate that with modern gasolines of winter volatility, satisfactory starting can be obtained at temperatures of −10° F. to −15° F. and that starting is possible at −20° F. to −35° F.

Evaporation Loss Tests

3—Evaporation Loss: Available data on the two sources of fuel evaporation loss in passenger cars, fuel tank and carburetor, were reviewed by Apjohn and Heath in 1948.(3) The lack of reliable information on modern automobiles led to an extensive research program by Socony-Vacuum Laboratories to evaluate these losses from postwar model cars.

The gasoline tank evaporation loss test was conducted under carefully controlled conditions in summer and winter driving, using 15 postwar model cars representing five of the most popular makes. Results of the tests are shown in Fig. 1 as a function of the true vapor pressure of the fuel. True vapor pressure is determined from the average ambient air temperature and the RVP of the fuel, correlations for its calculation being given in the CRC Handbook(2) and by Maxwell.(4) Evaporation losses from the fuel tank are shown to be of the order of 2 to 5 gals. per year. The average year-round true vapor pressure is about 5 psi. when using summer gasolines of 8-9 psi. RVP and 12-13 psi. with winter gasolines. At this true vapor pressure, the fuel tank evaporation loss would average 2.7 gals. per year if the tank were kept half full and 4.2 gals. per year if one-quarter full.

"While the magnitude of these losses appear insignificant when evaluated on a car-per-year basis," the paper states, "even these small losses total 2,500,000 bbls. of gasoline per year lost from the fuel tanks (one-half full) of passenger cars.

* Abstracted from paper "Motor Fuel Volatility Trends", by W. M. Holaday and D. P. Heath, Socony-Vacuum Laboratories. Presented at Annual Meeting, Society of Automotive Engineers, Detroit, Jan. 8-12, 1951.

The portion of the Holaday-Heath paper dealing with future trends in the volatility of motor fuels was published in the February PETROLEUM PROCESSING.

These evaporation losses of course will increase if higher vapor pressure fuels are marketed. The losses could be practically eliminated by the use of a pressure type gasoline tank and cap which would not vent vapor from the tank below 6 in. of mercury, gage pressure."

The carburetor evaporation loss tests were made on four late model cars, including two of the most popular makes. The carburetors were modified so that all vapor vented from the bowl could be measured by passing through a charcoal adsorber. A consistent relationship was shown between the true vapor pressure of the fuel in the carburetor bowl and the per cent of fuel vented, as given in Fig. 2.

In order to make the correlation in Fig. 2 more useful, a study of carburetor bowl fuel temperatures was made including a number of cars and representative of city and cross country driving under both summer and winter weather conditions. The average carburetor bowl fuel temperature was found to be approximately 35° F. above ambient air temperature. With average motor gasoline, this increase in fuel temperature will cause a loss at the carburetor of about 0.3 vol.%, which for the average motorist amounts to about 2 gals. per year (1,900,000 bbls. per year for all passenger cars).

"As would be expected from Fig. 2", stated the paper, "carburetor losses increase rapidly with increasing carburetor bowl temperature. In the case mentioned, an average temperature differential of 50° F. would have resulted in a loss per car of 6.5 gals. per year (6,000,000 bbls. for all passenger cars) and an average temperature differential of 65° F. an average loss of 27 gals. per year (25,000,000 bbls. for all passenger cars)."

4—Warm-up: While *average volatility* is the main fuel parameter affecting warm-up, both *initial volatility* and *final volatility* have minor influences on warm-up performance. A correlation was developed in the Socony-Vacuum Laboratories relating the 10, 50, and 90% evaporated temperatures of the ASTM distillation and the atmospheric temperatures to the miles required to obtain warmed-up performance. Several warm-up test programs conducted with postwar passenger cars have confirmed the validity of this relationship. It was reported.

5—Stalling: While engine stalling is usually the result of carburetor or ignition system malfunctioning, it can also be caused by fuels of high average volatility, either during the warm-up period or after the engine is completely warmed-up.

To test customer reaction to fuels of different volatility, the Socony-Vacuum Laboratories conducted a test in which 27 cars, mostly postwar models, were operated alternately on fuels of widely different volatility, as shown below:

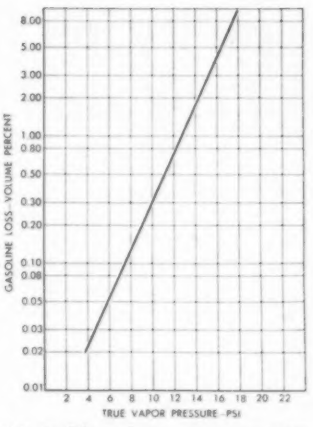


FIG. 2—Effect of vapor pressure upon carburetor evaporation losses

	High Vol. Fuel	Avg. Vol. Fuel
Reid Vapor Pressure, psi....	8.4	8.8
ASTM Distillation, ° F.		
10% Evaporated	129	134
50% Evaporated	161	221
90% Evaporated	212	320

When operating on the high volatility fuel, 21 of the 27 cars experienced operating difficulties associated with fuel volatility, practically all the complaints being of stalling under idling conditions. The most prevalent time of stalling was before the engine was thoroughly warmed up. None of the 27 cars experienced this difficulty when operating on the fuel of average volatility.

"Although very few data have been published on this problem", stated the paper, "it is believed to be associated with ice formation in the carburetor throat. Extremely volatile fuels evaporate rapidly in the carburetor throat. This rapid evaporation creates a refrigerating effect which, under the proper atmospheric conditions, will freeze out some of the moisture in the intake air. If this ice collects on the wall and covers the idle bleed hole, the engine will stall when the throttle is closed. In extreme cases, the ice formation can restrict the air flow sufficiently to cause a serious power loss."

The volatility limits for incipient stalling difficulties have not been established, it was stated, and it is difficult to estimate whether stalling will become of more importance as the result of engine design changes to be expected in the near future. The trend toward colder intake manifolds to obtain better volumetric efficiency and mechanical octane numbers may tend to accentuate stalling.

6—Acceleration: The influence of motor fuel volatility on passenger car acceleration is of minor importance. After warm-up, acceleration can be shown to be related to average volatility. With fuels covering the entire range of commercial volatilities, differences in acceleration are difficult to measure in a carefully controlled test; consequently, they are practically impossible for the customer to detect.

7—Fuel Economy: This is influenced only slightly by fuel volatility. The heat content is a function of the specific gravity of the fuel, which to a degree is controlled by the final volatility of the fuel. The heavier, less volatile fuel tends to give better fuel economy. However, the possible difference in fuel economy between the extremes of commercially available motor gasoline is of the order of 5 to 6%.

8—Crankcase Oil Dilution: As final volatility of the fuel decreases, crankcase oil dilution increases as measured by the ASTM dilution test. The increase is not uniform for all vehicles, as the amount is affected greatly by engine characteristics, engine maintenance, operating conditions and atmospheric temperatures. Tests made in Socony-Vacuum Laboratories on over 1700 samples of used oil collected over 2½ years showed the average dilution increased from about 1.2% in summer to 3% in winter. Information on the effect of fuel volatility on dilution obtained on a number of passenger cars and trucks indicated that an increase of 50° F. in the 90% point would increase the average dilution to about 3% in summer and 7.5% in winter.

No adverse effects of dilution were noted in road tests of both prewar and postwar models, even in cases where the dilution had been high, from the use of heavier fuels.

9—Engine Cleanliness: Both thermally and catalytically cracked fuels having 90% points in excess of 330° F. can be shown to have an adverse effect on engine cleanliness, if they are tested untreated. However, given the usual refinery finishing treatment, the deposit forming tendencies are effectively reduced.

In door-to-door delivery trucks, extremely low temperature sludge and lacquer deposits have been encountered as a result of excessively low engine operating temperatures and lack of adequate crankcase ventilation. Here fuel volatility may be one of the factors influencing the extent of deposits formed.

Bibliography

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(2) CRC Handbook, 1946 Edition, Coordinating Research Council, New York.
(3) Apjohn, T. L. and Heath, D. P., "Problems in the Efficient Utilization of Refinery Butanes", *Proceedings American Petroleum Institute*, Vol. 28M (III), p. 85 (1948).
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The first combination topping and decarbonizing unit and the first integrated Fluid catalytic cracker and cat poly unit were designed for this project.

At about the same time, Canadian Kellogg moved further west to design and construct a deasphalting unit for B-A's Clarkson Refinery.

And now, on the approaches to Canada's great, new western oil fields, Canadian Kellogg is constructing—at Edmonton, Alberta—a complete new refinery including Fluid catalytic cracking for this outstanding Canadian refiner.

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A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

"Ally of Process Development"

The first of these camera "portraits" of M. W. Kellogg today, which appeared last month in this publication, pointed up the completeness of the Kellogg organization working in the laboratory phases of applied chemical research and process development.

This month, some aspects of Kellogg's completely integrated Metallurgical Engineering Division are high-lighted to indicate the vital role they play in the advancement of processing, engineering and fabrication.

1. ***PARALLELING KELLOGG'S*** growth in the processing phase of oil refining has been its contribution to metal fabrication—a contribution based on early and continuing metallurgical research. As processing conditions have become continuously more severe and more exacting, this research has resulted in the creation of new, more precise specifications for materials . . . new methods of fabricating . . . and new methods of testing.

4. ***PHOTOMICROGRAPHY, TOO,*** plays an important part in Kellogg's metals research. It has proved particularly helpful to the company in its improvement of welding techniques both for shop and field fabrication. Demand for such metallurgical developments has so increased in the last decade that the original metallurgical laboratory has been expanded into a complete Metallurgical Engineering Division.

5. ***X-RAY DIFFRACTION*** serves continuously in Kellogg's investigation of metals for process applications—investigations conducted to develop metals for service at temperatures from about 300°F. to 5,000°F., and pressures up to 3000 pounds per square inch, and in the presence of such virulent corrosives as hydrofluoric and nitric acids.

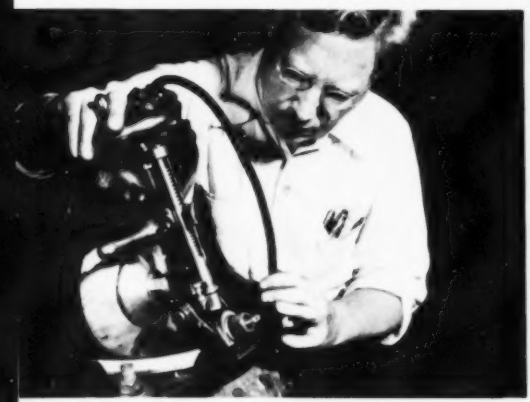
Fifty... no 2

M KELLOGG W
1901 1951
50th Anniversary

we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit . . . the forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 2 in the series.

2. *VESSELS, PIPING* and other metal equipment are, of course, the backbone of the refining industry. Moreover, high-temperature, high-pressure piping installations for utility power stations comprise the company's second largest sales operation. To meet the technical demands of this business, the characteristics of metals under a wide variety of conditions must be studied continuously, with modern test equipment.

3. *KELLOGG TODAY OPERATES* one of the most complete creep laboratories in the country, to study metals under all manner of temperature and load conditions. This biaxial test unit—believed to be the only one of its kind—exerts a two-directional stress at high temperature. In operation, tubular metal specimens are pulled apart at the same time as internal gas pressure seeks to burst them circumferentially.



6. *THIS INTERESTING TOOL*, termed a weld prober, was pioneered by the company's metallurgists for the study of *graphitization* in piping. This unusual metal "disease" was originally discovered in power piping operating under continuous high temperatures and pressures. The weld prober contributes significantly to the study, by permitting the removal of samples of welds and piping while the pipe remains in service position.

7. *MAGNETIC*, fluorescent dye and ultrasonic techniques—all non destructive test methods—are also employed to explore the characteristics of metals before and after service under varying operating conditions. Guiding this continuing research into metal behaviour is a group of engineers and scientists who are internationally famous in their specialties, leaders on industry code committees, and members of key technical Defense groups.

NEXT MONTH

. . . in the third in this series of camera studies of M. W. Kellogg today . . . you will glimpse a few of the many development projects which utilize the results of these metallurgical studies.

M. W. KELLOGG

Large and small vessels for handling unusual corrosives . . . extremes in high and low temperature operations . . . high vacuum to high pressure—these are the vessels that refiners time after time "earmark" for Kellogg, because Kellogg-fabricated vessels measure up when the going is tough.

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Vacuum Vessels
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Continuing Study of behavior of metals under stress at high temperatures has produced valuable design data.

Shop Layout Craftsmen are fully experienced in vessel fabrication from nozzle positioning to "knockdown" fabrication for field assembly.

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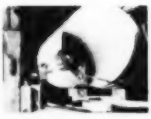

Rigid Quality Control through non-destructive inspection, maintained by inspectors reporting directly to management.

NEWS FOR OPERATORS IN WESTERN CANADA

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

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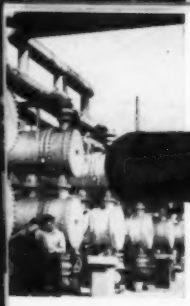


Less Time and Metal in Improved Strip Lining

LESS time for installation and lower weld metal requirements are advantages cited by Globe Oil & Refining Co., Lemont, Illinois, for an improved method of applying alloy strip lining to process vessels developed in their refinery.

The new method, shown at the right in Fig. 1, consists of overlapping the individual plates comprising the lining. It replaces the previous method, shown at the left above, in which plates were laid flat on the vessel wall and then welded by the conventional three-bead technique. The new method requires one less bead per plate, thus saving time and electrodes. The lap, exaggerated in the drawing to show detail, usually is kept within the range of ⅛ to 3/16 in.

Another important advantage of the new method is in increased resistance to corrosion, Globe engineers state. This is more clearly indicated in the cross sectional views. With the previous method, all exposed weld metal also contacts the base metal: with the new, an average of half the weld metal is concealed beneath the plate and therefore is not exposed.

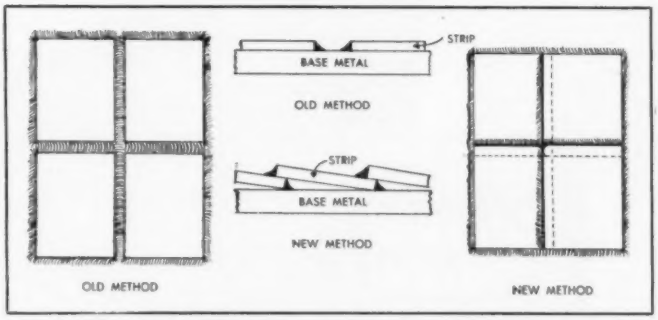


FIG. 1—OVERLAPPING TECHNIQUE reduces weld metal requirements by using only two beads for attaching strip lining to vessel interiors

Multiple Insulation Technique Provides Multiple Protection for Process Lines

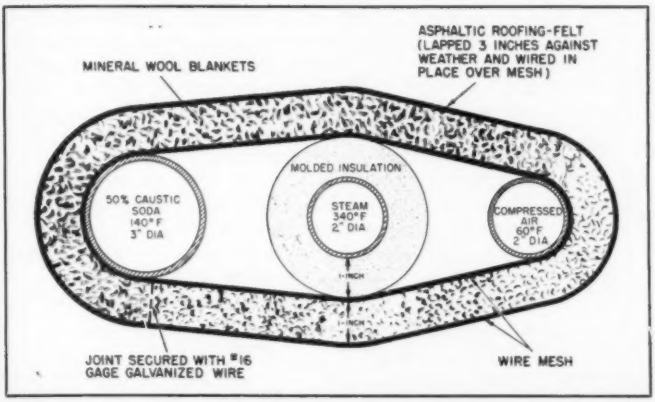

ASPHALTIC ROOFING-FELT (LAPPED 3 INCHES AGAINST WEATHER AND WIRED IN PLACE OVER MESH)
MINERAL WOOL BLANKETS
MOLDED INSULATION
50% CAUSTIC SODA 140° F 3" DIA
STEAM 340° F 2" DIA
COMPRESSED AIR 60° F 2" DIA
1 INCH
1 INCH
JOINT SECURED WITH #16 GAGE GALVANIZED WIRE
WIRE MESH

FIG. 2—Insulation-within-insulation gives two-way protection of outdoor process lines

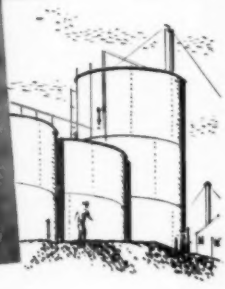
A SINGLE, especially - designed application of mineral wool insulation in a Niagara Falls chemical plant is serving simultaneously to guard against freezing and prevent overheating in process lines and to control heat loss from a steam line. The practice is equally adaptable to petroleum refinery process lines.

Generally when the contents of an outdoor process line must be kept from freezing, a steam line is run parallel to it, and the two lines are insulated within one insulation covering. The steam heats the process fluid, the insulation provides protection from extreme temperature variations due to weather, and freezing during the winter is eliminated.

However, when Stauffer Chemical Co. planned to apply this technique and make use of a 340° F. steam line, it was found that the steam would overheat the process lines—in this case, one carrying caustic soda and the other compressed air.

The solution as worked out was to insulate the steam line to a thickness which would permit escape of only enough heat to prevent freezing of the caustic soda and of moisture in

ONE is good... FOUR are BETTER!



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(To obtain more data on advertised products see page 312)

the compressed air. Then the three pipes were encased in an overall covering of mineral wool, protecting the process lines both from freezing and overheating. Further, the steam line was sufficiently insulated by the double layer to prevent heat from wasting to the atmosphere. Summertime overheating of the process lines was also prevented by this technique.

The method is illustrated in the cross-sectional drawing in Fig. 2. First, after removal of extraneous material such as grease and dust from the pipelines, one-inch molded sectional pipe insulation is applied over the entire surface of the two-inch steam pipe with the sections tightly butted together and securely held in place by metal bands.

Second, mineral wool blankets, sandwiched between facings of wire mesh, are cut and shaped around the three pipelines. The blankets are then wired in place with 16-gauge galvanized wire. Abutting ends and edges of the blankets are tightly laced together with 16-gauge galvanized wire woven into the mesh coverings. To complete the outdoor installation, asphaltic roofing felt is wrapped around the entire surface, lapped three inches, and bound on approximately 6-inch centers by galvanized wires wrapped around the flet and tightly secured.—*The Industrial Mineral Wool Institute.*

Concrete Construction More Efficient Using Metal Instead of Wooden Forms

INCREASED efficiency in constructing pump foundations and concrete column supports at the Esso Standard Oil Co. Baltimore refinery has been effected through the use of standard sheet metal forms in place of the previously used wooden form.

The building trades department found that most pump foundations and practically all structural columns could be covered with a set of four standard metal forms. For example, structural columns are all either 16 or 20 inches square. In both cases—pumps or structural columns—a light gage sheet metal is used and is formed in two halves. The halves are bolted together at diagonally opposite corners. It was found necessary to grease the surfaces lightly before pouring the concrete so as to facilitate removal later of the sheet metal forms.

Two distinct advantages of the method are as follows: 1) Far less time is required to assemble the metal forms as compared with building wooden forms, and 2) once the wooden form has been used it is usually not salvaged anyway.

The new metal forms as used for pump foundations, are of course a trifle more complex than those used for structural columns however, Baltimore personnel have found that even this type of foundation can be greatly simplified by standardizing dimensions and the like.

Finger Brake Saves Wear On Tank Gagers' Hands

A SIMPLE little gadget which saves wear and tear on a tank gager's thumb has been worked out by maintenance personnel at Socony-Vacuum Oil Co.'s Olean, N. Y., refinery. It consists merely of a brake made of a strip of steel, copper, brass, or anything handy. Fastened to the outer end of the gage tape holder, it curves around the reel and provides an easy thumb-operated brake.

The device is especially helpful on older tapes which have been repaired by piecing short lengths together. In such cases, the points of repair were particularly rough on the gager's thumb if he tried to control the rotation of the reel by direct contact.

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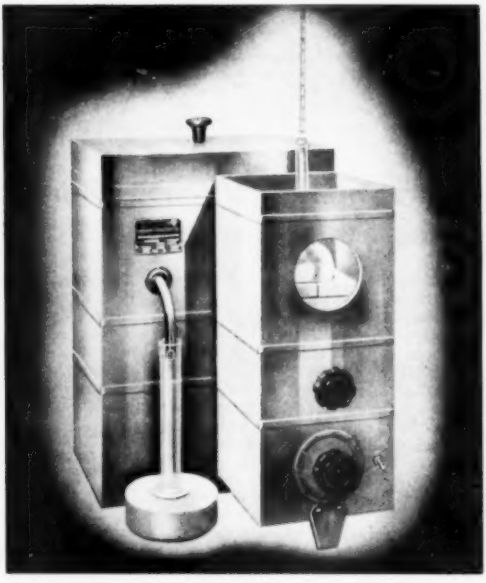

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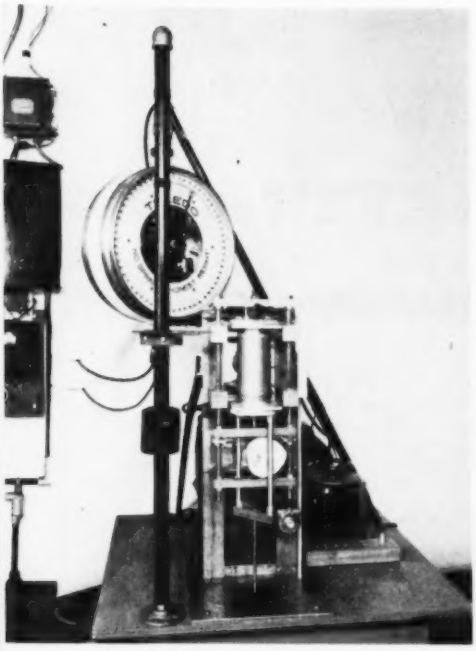
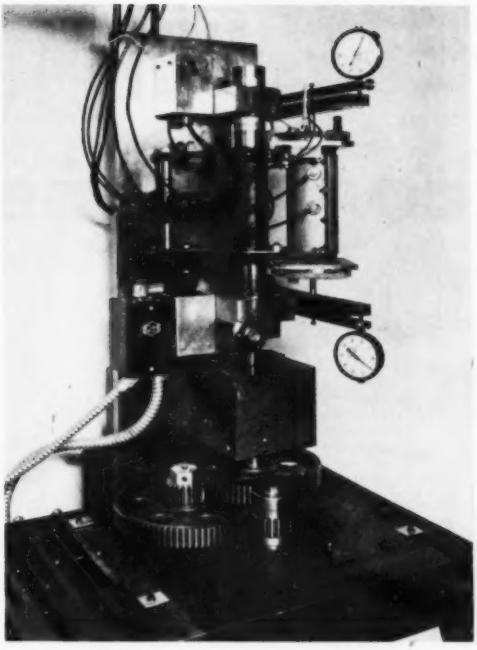


CAM-OPERATED worker-consistometer



SCREW-OPERATED worker-consistometer

Grease Consistometer Is Modified to Operate At Constant Shear Rates, Higher Viscosities

MODIFICATIONS in the McKee Worker-Consistometer[1], made recently at the National Bureau of Standards, where the original instrument was developed, have made it useful in studies of the rheological properties of rubber and rubber solutions as well as greases and similar substances, by permitting operation at constant nominal rates of shear and extending the viscosity range.[2]

In its original form, the instrument employed weights to provide various constant loads at which flow rate measurements were made. The modifications concern chiefly the driving mechanism and the method for measuring the forces involved. Two constant speed drives have been constructed. One is a cam-operated mechanism with a load range up to 200 lbs. The other is a screw-operated drive with a capacity of 1600 lbs. The operation of each is automatic and is such that the readings of the forces may be taken at intervals during the run of continual working.

Design of the major elements has been retained. The worker unit consists of two coaxial steel cylinders and mating pistons with a capillary type shearing element between them. Relative motion between pistons and cylinders forces the test material through the shearing element. Each unit is provided with 1-hole, 10-hole, and 50-hole shearing elements which are made by drilling holes in circular steel disks ¼-in. thick, using a No. 79 drill. This produces capillaries in the disks ¼ in. long and about 0.015 in. in diameter.

Cam-Operated Unit

In the cam-operated apparatus, the pistons are moved back and forth and determinations of the pressure developed in pushing the sample through the capillaries in the shearing element are made by measuring the force required to hold the cylinders in a fixed position. The worker unit is enclosed in a duralumin housing, which in turn is encircled by an electric heater. A mercury-in-glass thermal regulator controls the test temperature which is measured by a thermocouple in contact with the shearing element. Flanges at the ends of the housing are attached to flexure plates which provide "free" action along the vertical axis. Push rods, actuated by the cam through a connecting yoke, move the pistons back and forth a distance of approximately 2 in. During the upward pass, the force required to push the material through the shearing element is measured by a weighing scale, which is connected to the cylinder assembly by rods acting through an 8-to-1 lever arm. The arrangement is such that the load range is from 1 to 200 lbs.

The driving mechanism and the series of disks provide a continuous range of nominal rates of shear from 200 to 100,000 reciprocal seconds. However, this range is limited for any given material by the load span of 1 to 200 lbs. For the entire range, this load span corresponds to viscosities of 1 to 100 poises; while, for the relatively low rate of 200 recipro-

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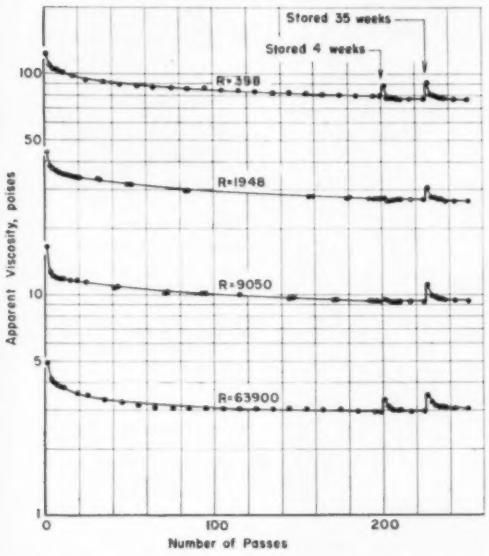


FIG. 1—Apparent viscosity of a grease at 100° F. as influenced by working and subsequent storage. Numbers on curves indicate rate of shear during each test

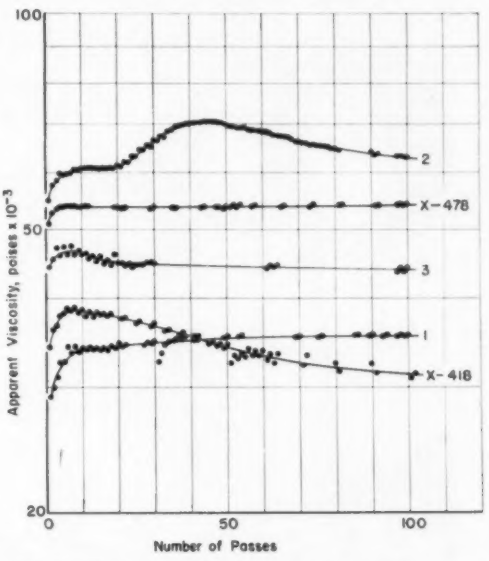


FIG. 2—Effect of working on apparent viscosity of five synthetic rubbers at 212° F., at a rate of shear of 99 reciprocal seconds. Samples x-418 and x-478 are commercial products, the others are experimental samples

cal seconds, the viscosity range is from 20 to 4000 poises.

Screw-Operated Unit

In the screw-operated apparatus, the cylinders of the worker unit are moved back and forth, and the force measured is that required to hold the pistons in a fixed position. The unit is enclosed in a temperature-controlled steel housing which is attached to a steel operating yoke so as to permit vertical motion, but no rotation. This yoke is driven through a screw and nut by a reversible gear motor, and interchangeable gear trains provide changes in speed. Adjustable screws on the yoke contact push buttons, thus operating magnetic switches which automatically reverse the motor at the end of each upward and downward stroke of the yoke. These screws and push buttons are adjusted for a stroke of about two in.

During the reciprocating motion of the cylinders, the pistons are held stationary by loading pins acting against calibrated steel springs. A dial indicator measures the deflection of the cantilever arm of the spring and hence the force necessary to push the test material through the capillaries in the sheating element. Five pairs of springs of different capacity cover the range of loads up to 1600 lbs. The gear trains provide a number of rates of shear ranging from less than 1 up to 100,000 reciprocal seconds. The viscosity range is 8 times greater than that of the cam mechanism for its range of shear rate (200 to 100,000 reciprocal seconds). With the screw-operated apparatus, the range of viscosity determinations is extended to 600,000 poises at 10 reciprocal seconds or 6,000,000 poises at 1 reciprocal second.

Typical Tests

In a typical test with the worker consistometer, for example, a lubricating grease operating at 100° F. was investigated at various constant rates of shear. During each run at a given rate of shear, flow measurements were taken at intervals throughout a period of mechanical working of 200 passes, after which the sample was transferred to a storage cylinder. After four weeks of storage at room temperature, flow measurements were again made with each sample during a working period of 26 passes. They were then subjected to an additional storage time of 35 weeks and another 26-pass working period.

With this grease, the effect of mechanical working in lowering the viscosity was quite marked during the first 200 passes (See Fig. 1). The change in viscosity was found to be roughly proportional to all rates of shear over the range covered. The data taken at the first pass after a storage period provide an indication of the so-called healing process. Generally, there is a measurable increase in viscosity after storage. Apparently the grease becomes relatively stable (with respect to mechanical working) after the first working period, since subsequent working after storage does not lower the viscosity much below that at the 200th pass.

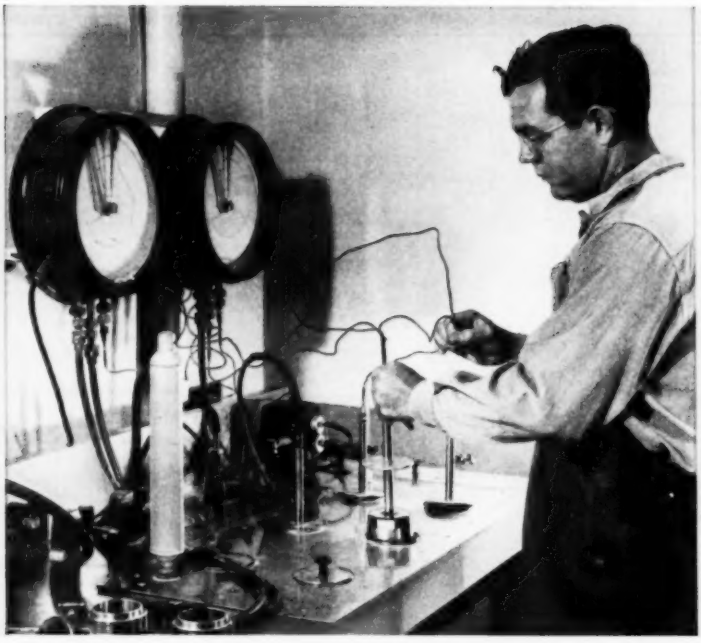
The consistometer has also provided important data on the effect of working on the viscosity of five GR-S rubbers: two in commercial production, and three special experimental samples. In these tests, 100 passes were made with each sample at a rate of shear of 99 reciprocal seconds and at a temperature of 212° F. There was an increase in viscosity in each case during the first few passes, after which the behavior was different for different samples. (See Fig. 2).

One of the chief advantages of the worker-consistometer is that various materials may be worked and their flow characteristics measured in the same series of operations.

References

(1) "New Device Combines Grease Working with Flow Measurement in Single Unit," PETROLEUM PROCESSING, April, 1949, pages 427-8.

(2) "The McKee Worker-Consistometer with Constant-Speed Drives," by S. A. McKee, *J. Research NBS*, Vol. 46, No. 18, RP 2170 (1951).



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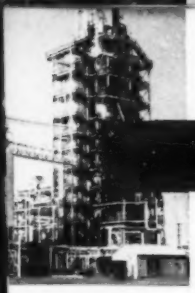


PROCESSING PATENTS

New Developments in Processes and Products

By **PETER J. GAYLOR**
Editor, "The Technical Survey"

Gasoline Sweetening Process May Be Source of Sulfur

IN VIEW of the increasing interest in sources of sulfur for sulfuric acid, attention might be brought to one recent patent issued to Shell Development Co. (U. S. 2,530,701). In this case a high sulphur-content cracking feedstock containing at least 0.5% sulfur is cracked in the presence of a clay catalyst, and the mercaptan-containing distillate is treated to remove mercaptans, which are oxidized to disulfides. The disulfides are then mixed with the feedstock prior to the cracking operation, and subsequently recovered.

A flow-sheet of the steps involved is depicted in Fig. 1. Distillate from the catalytic cracking unit, 1, is extracted by alkali in extraction unit 3. The mercaptans so removed are oxidized in unit 5, wherein wash oil fed in through line 6 removes the disulfides. The desulfide oil mixture is recycled through line 7 to the cracking operation, and all of the useful sulfur recovered in this case is in the form of hydrogen sulfide, which is removed from the cracking step via unit 2.

It was found that disulfides crack easily and practically completely under cracking conditions to give a yield of about 80-85% of hydrogen sulfide. About 6-8% of the disulfides are absorbed on the catalyst and removed as sulfur dioxide with the regeneration gases. About 3-5% of the sulfur remains in the gasoline while 2-11% remains in the higher boiling products. The hydrogen sulfide recovered can, of course, be converted to sulfuric acid in the conventional manner.

"Lubricant" Aids Pumping Of Oils in Pipe Lines

ORDINARILY, one would believe that oil is a satisfactory lubricant for itself and that when it is pumped through pipes it would move with ease due to its lubricity and low coefficient of friction with respect to the metal surface. However, Socony-Vacuum Oil Co., in its U. S. Patent 2,533,878, discloses that the transportation of very viscous petroleum by pipe line, particularly during cold weather, may be facilitated considerably by the use of water containing minute proportions of a water-soluble anionic surface-active agent, together with an alkali-metal phosphate. This coats the surface of the metal pipe, "lubricating" it so that the viscous oil glides over it more rapidly, thus enabling a lower pressure on the pipe line for a given volume throughout.

Any water-soluble anionic surface-active agent will give good results when employed in proportions of 0.02% by weight with respect to the water, which is used in the proportion of 8%-15% of the total liquid carried by the pipe line. A suitable material is the sodium or potassium salt of dodecylbenzyl sulfonic acid. However, if such compounds are used alone, they tend to emulsify with the oil and thus lose their desired effect. In order to overcome this, alkali-metal phosphates, such as commercial tri-sodium phosphate, are added and, if the water is very hard, it is preferable to use polyphosphates having a sequestering effect, such as sodium hexametaphosphate. After the addition of the surface-active agent and phosphate, if the pH of the water is not within the limits of 5.7 to 7.0, the solution is adjusted to within this range by acidic or basic electrolytes. The phosphate yields good results when added in proportion of 0.005% or more with respect to the water used. It is pointed out that petroleum sulfonates are satisfactory surface-active agents for this purpose. Actual transportation data are given to show the reduction in pipe line pressure for a given throughput.

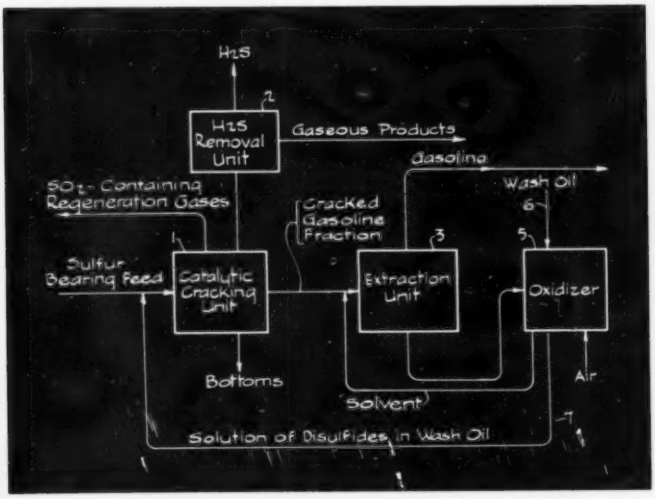


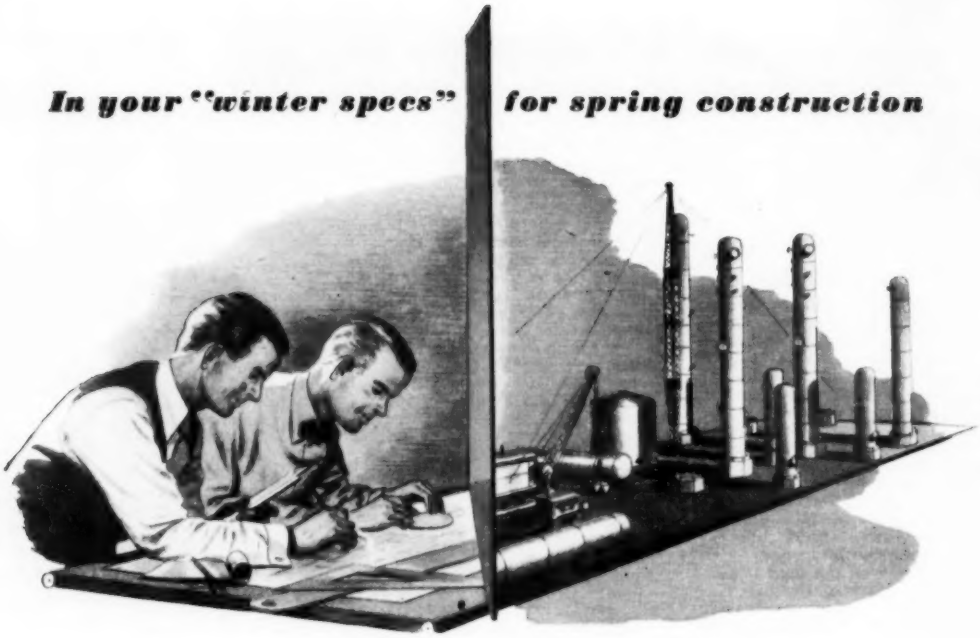
FIG. 1—Flow diagram for new Shell process for sweetening of distillates and cracking of recovered disulfides (U. S. 2,530,701)

Removal of Mercaptans With Ethylene Oxide

ONE interesting testing method, which may still be rather expensive, deals with the removal of mercaptans from distillates by dethiolizing, which involves reacting at high pressure with ethylene oxide. A patent issued to The Texas Co. (U. S. 2,530,561) points out that the probable mechanism involves a condensation in which the mercaptan reacts to produce beta-hydroxyethyl-alkyl or aryl thioethers. Since these condensation products are higher boiling than the hydrocarbon treated, they may be separated by fractionation. When treating higher boiling stocks, such as kerosine, it is considered more practical to separate the hydrocarbon from the condensation products by water washing.

In one example, a sour propane-propylene mixture containing 0.03% by weight of total lamp sulfur was contacted with 5% by weight of ethylene oxide in a closed bomb for two hours at 200° F. The treated hydrocarbon was then released, leaving the residual reaction products in the bomb.

In your "winter specs" for spring construction



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The sulfur content of the treated product was reduced to 0.004% in this manner. Although catalysts are not required, metal oxides or sulfides may be employed.

Additive Lubricating Oils

OIL-SOLUBLE magnesium sulfonates, when used in combination with an oil-soluble phosphorus-and-sulfur-containing reaction product of a dicyclic terpene and a phosphorous sulfide, have been found to be particularly effective in improving corrosion and oxidation characteristics of mineral oils, according to U.S. Patent 2,476,972 issued to Socony-Vacuum Oil Co

Patents Issued in January

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of direct interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for January 2, 9, 16, 23 and 30, Vol. 642, Nos. 1-5.

Chemicals

Re. 23,318 (Pure Oil Co.)—Sulfur vaporization.
U.S. 2,536,040 (Shell Development Co.)—Purifying alkyl phenols.
U.S. 2,536,680 (Pure Oil Co.)—Catalysts and process for producing carbon disulfide by reacting hydrocarbons with sulfur.
U.S. 2,536,684 (Shell Development Co.)—Sulfurized polymer.
U.S. 2,536,845 (Standard Oil Development Co.)—Drying oil dimer copolymers.
U.S. 2,537,079 & 687 (Standard Oil Development Co.)—Preventing cake formation in acetone pyrolysis to ketene.
U.S. 2,537,130 (Standard Oil Development Co.)—Recovering isobutylene polymer.
U.S. 2,537,133 (Standard Oil Development Co.)—Recovering organic acids from dilute aqueous solutions.
U.S. 2,537,304 (California Research Corp.)—Electrolysis, using mercury electrode.
U.S. 2,537,334 (Shell Development Co.)—Emulsion polymerization of vinylidine compounds.
U.S. 2,537,446 (The Texas Co.)—Fused cyclic thiophenes.
U.S. 2,537,568 (Standard Oil Development Co.)—Cis-butene oxidation.
U.S. 2,537,576 (Standard Oil Development Co.)—Recovery and purification of naphthenic acids.
U.S. 2,537,577 (Standard Oil Development Co.)—Selective oxidation for producing fatty acids and alcohols.
U.S. 2,537,579 (Shell Development Co.)—Stabilizing 3, 4-dihydro-1,2-pyran-2-carboxaldehyde.
U.S. 2,537,658 (Standard Oil Development Co.)—Recovery of fatty acids from dilute aqueous solutions.
U.S. 2,537,759 (Atlantic Refining Co.)—Low temperature filtration of hydrocarbon polymers.
U.S. 2,537,845 (Shell Development Co.)—Alkenyl esters of endoalkylene-tetrahydrophthalic acids.
U.S. 2,537,853 (Shell Development Co.)—2,2-Bis (tert-butylperoxy) butane.
U.S. 2,537,857 (Shell Development Co.)—Coupling amines with dialkyl peroxides.
U.S. 2,537,921 (Shell Development Co.)—Polymers of esters of oxyheterocyclic carbinols.
U.S. 2,538,254 (Pan American Refining Corp.)—Ketone plasticizers for polyvinyl chloride resins.
U.S. 2,538,297 (Shell Development Co.)—Heat and light stable vinyl resin compositions.
U.S. 2,538,298 (Socony-Vacuum Oil Co.)—Polynitro organic compounds.
U.S. 2,539,394 (The Texas Co.)—Separating aldehydes from mixtures.
U.S. 2,539,523 (Atlantic Refining Co.)—Polymerization of olefin mixtures.
U.S. 2,539,675 (Universal Oil Products Co.)—Modification of properties of unsaturated conjoint polymers.
U.S. 2,539,685 (Shell Development Co.)—Diamine fatty acid salts.
U.S. 2,539,824 (Standard Oil Development Co.)—Nitration derivatives of hydrocarbon polymers.
U.S. 2,540,047 (Shell Development Co.)—Cryst. complexes of sterols with oximes.

Refining

U.S. 2,536,373 (Universal Oil Products Co.)—Extraction column.
U.S. 2,536,436 (Phillips Petroleum Co.)—Pebble heater chamber.
U.S. 2,537,045 (Hydrocarbon Research Inc.)—Cooling gases containing condensable material.
U.S. 2,537,076 (Standard Oil Co.—Ind.)—HF recovery.
U.S. 2,537,448 (Shell Development Co.)—Purifying gases.
U.S. 2,537,459 (Griswald)—Recovery of pure hydrocarbons by extractive distillation with aniline.
U.S. 2,537,620 (Standard Oil Development Co.)—Desulfurizing oils with bauxite.
U. S. 2,537,756 (Percuel Corp.)—Desulfurizing hydrocarbons with bauxite.
U.S. 2,537,999 (Socony-Vacuum Oil Co.)—Deoiled waxy product and gasoline from waxy oils.
U.S. 2,538,220 (Standard Oil Development Co.)—Deasphalting petroleum oils.
U.S. 2,538,262 (Universal Oil Products Co.)—Removing water solubles from sulfuric acid alkylates.
U.S. 2,538,287 (Standard Oil Co.—Ind.)—Regenerating alcohol-caustic solution.
U.S. 2,538,293 (Phillips Petroleum Co.)—Fluosulfonic acid refining of lubricating oil.
U.S. 2,538,870 (Atlantic Refining Co.)—Dewaxing hydrocarbon oil with vortex separator.
U.S. 2,539,074 (Union Oil Co. of Calif.)—Electrical process for dehydrating oil.
U.S. 2,539,142 (Phillips Petroleum Co.)—Contracting apparatus.
U.S. 2,539,898 (Phillips Petroleum Co.)—Sweetening sour distillates with adsorbent impregnated with copper salt.

Conversions

U.S. 2,536,085 (Phillips Petroleum Co.)—Gel-type dehydrogenation catalyst.
U.S. 2,536,254 (Sinclair Refining Co.)—Catalytic conversion of hydrocarbons.
U.S. 2,536,307 (Sinclair Refining Co.)—Catalytic conversion apparatus.
U.S. 2,536,402 (Standard Oil Co.—Ind.)—Fluidized solids transfer.
U.S. 2,536,514-5 (Socony-Vacuum Oil Co.)—Alkylation of hydrocarbons (HF).
U.S. 2,536,841 (Standard Oil Development Co.)—Low-temperature olefin polymerization with sulfur-containing catalyst.
U.S. 2,537,153 (Standard Oil Development Co.)—Fluidized carbonization process.
U.S. 2,537,282 (Universal Oil Products Co.)—Polymerizing olefins.
U.S. 2,538,001 (Universal Oil Products Co.)—Polyolefins from HF sludge.
U.S. 2,538,030 (Houdry Process Corp.)—Apparatus for contacting fluent solids with gases.
U.S. 2,538,219 (Standard Oil Development Co.)—Fluid solids technique in coal gasification.
U.S. 2,538,248 (Universal Oil Products Co.)—Isomerizing olefins with copper - nickel-silica catalyst.
U.S. 2,539,350 (Socony-Vacuum Oil Co.)—Alkylating isobutane with propylene.
U.S. 2,539,583 (Sinclair Refining Co.)—Catalytic conversion of hydrocarbons with finely divided catalyst in two stages.

Catalysts

U.S. 2,537,272 (Universal Oil Products Co.)—Regenerating moving catalyst.
U.S. 2,537,685 (Standard Oil Development Co.) Fluidized catalyst apparatus.
U.S. 2,538,345 (Phillips Petroleum Co.)—Aluminum halide catalysts.

Hydrocarbon Synthesis

U.S. 2,537,044 & 046 (Hydrocarbon Research Inc.)—Continuous production of oxygen.
U.S. 2,537,178 (Standard Oil Development Co.)—Minimizing ester formation in hydrocarbon synthesis.
U.S. 2,537,496 (The Texas Co.)—Hydrocarbon synthesis.
U.S. 2,537,688 (Standard Oil Development Co.)—Synthesizing hydrocarbons and oxygenated compounds.
U.S. 2,537,699 (Standard Oil Development Co.)—Magnetite-containing synthesis catalyst.
U.S. 2,537,708 (Standard Oil Development Co.)—Hydrogen-containing gas under pressure.
U.S. 2,538,235 (Standard Oil Co.—Ind.)—Hydrogen.
U.S. 2,539,393 (The Texas Co.)—Separation of heterogeneous mixture of compounds obtained in hydrocarbon synthesis.
U.S. 2,539,414 (Hydrocarbon Research, Inc.)—Catalytic reduction of carbon oxide with hydrogen.
U.S. 2,539,415 (Hydrocarbon Research, Inc.)—Hydrocarbon synthesis.
U.S. 2,539,434 (Hydrocarbon Research, Inc.)—Hydrocarbon synthesis.
U.S. 2,539,847 (M. W. Kellogg Co.)—Hydrogenating carbon monoxide.

Specialties

U.S. 2,536,403 (Standard Oil Co.—Ind.)—Quenching oil.
U.S. 2,537,055 (Shell Development Co.)—Aqueous emulsion paints.
U.S. 2,537,608 (Standard Oil Development Co.)—Selective crab grass herbicidal compositions.
U.S. 2,538,482 (Phillips Petroleum Co.)—Treating carbon black.
U.S. 2,539,909 (Sun Oil Co.)—Insecticide containing reaction product of ethylene chlorohydrin.
U.S. 2,539,910 (Sun Oil Co.)—Insecticide containing 1,4 dithiocyanobutene-2.

Lubricants

U.S. 2,536,685 (Shell Development Co.)—E. P. agent for synthetic lubes.
U.S. 2,537,297 (Standard Oil Co.—Ind.)—Sulfurizing terpenes.
U.S. 2,537,926 (Socony-Vacuum Oil Co.)—Phosphorus-sulfur-containing material.
U.S. 2,538,066 (Standard Oil Co.—Ohio)—Lubricating oil from crude distillate.
U.S. 2,538,696 (Sinclair Refining Co.)—Inhibited and detergentized lubricating oil.
U.S. 2,539,422 (Ward Baking Co.)—Emulsion resistant crank case oil containing cyclohexyl sulfate compound.
U.S. 2,539,424 (Standard Oil Co.—Ohio)—Esters of P_2S_5-amine reaction products as lube oil additives.
U.S. 2,539,503-4 (Zisman et al) Fluid ester lubricating compositions.

Fuels

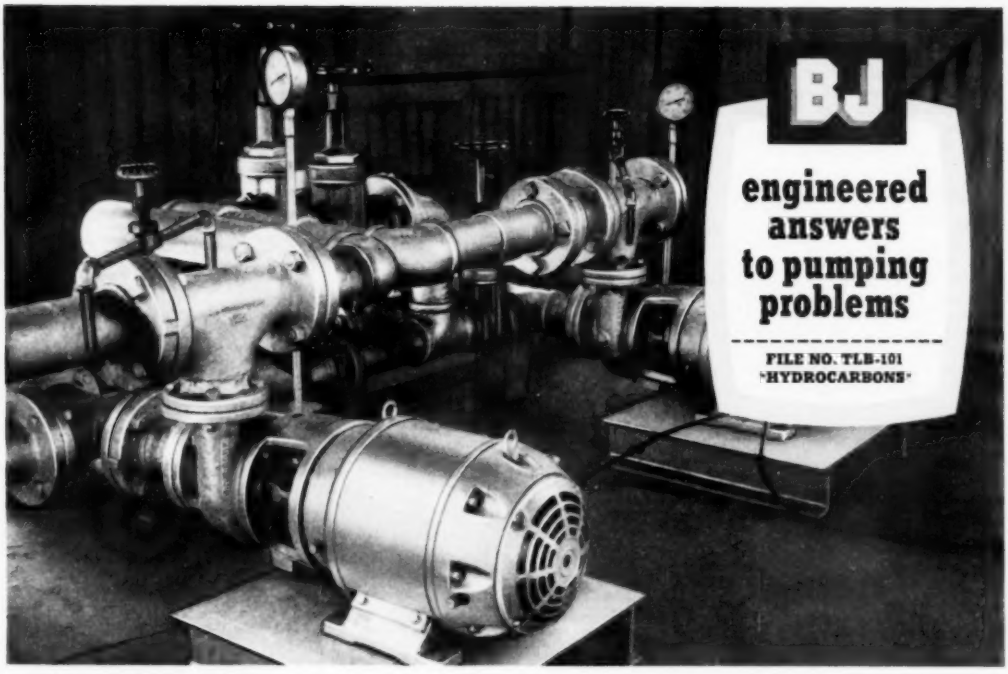
U.S. 2,537,526 (Borg-Warner Corp.)—Nitroparaffin fuel.
U.S. 2,538,516 (Borg-Warner Corp.)—Nitromethane, tetranitromethane and water.
U.S. 2,538,664 (Phillips Petroleum Co.)—Shipping and storing liquefied gases.
U.S. 2,539,118-9 (Socony-Vacuum Oil Co.)—Manufacture of carbureted water gas.
U.S. 2,539,915 (Akt. Separator, Sweden)—Purifying heavy boiler oil.

Miscellaneous

U.S. 2,537,085 (Warren Petroleum Corp.)—Cargo-type tank vessels having separable tanks.
U.S. 2,537,137 (Standard Oil Development Co.)—Rectilinear pen recorder.
U.S. 2,537,737 (Atlantic Refining Co.)—Detecting leaks in pipe lines.
U.S. 2,538,710 (Phillips Petroleum Co.)—Analyzing gaseous hydrocarbons.
U.S. 2,539,453 (Warren Petroleum Co.)—Apparatus for mounting tanks in a cargo vessel.
U.S. 2,539,478 (Standard Oil Co.—Ohio)—Disposing of slop oil.
U.S. 2,539,843 (Phillips Petroleum Co.)—Hydrostatic testing of pressure vessels.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25 cents each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.



General Petroleum reports:

Mechanically-sealed BJ Type TLB Pumps handle hydrocarbons without leakage, fire hazard, repacking problems or special operating attention

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The installation shown above is at General Petroleum's Bakersfield Bulk Plant. Two BJ Type TLB Pumps are used here for loading gasoline and diesel fuels, pumping 160 gpm against 62 ft. total head. Explosion-proof 3 hp, 3-phase, 60 cycle, 220/440 v motors operate at 3550 rpm.

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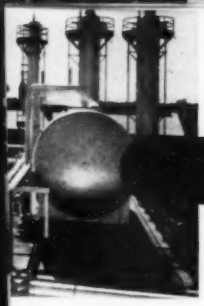
(*To obtain more data on advertised products see page* 312)



EQUIPMENT PATENTS

Brief Reviews of New Inventions in Equipment

Slanting Bubble Caps Improve Fractionator Tower Efficiency

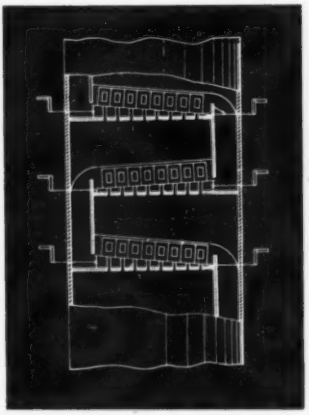


FIG. 1—ADJUSTABLE SLOPE used in bubble cap assemblies for fractionation column (U.S. 2,539,142)

VAPOR distribution, and therefore tower efficiency, can be improved in a bubble cap fractionator by means of an arrangement whereby the height of individual bubble caps above the tray is adjusted as tower operating conditions change.

In a conventional column with horizontal trays and all caps at the same height above each tray, downcoming liquid tends to assume a greater depth at the entrance point on the tray than it has at the overflow weir. As a result, some caps are relatively more active than others. Vapor flow is not uniform through all risers and bubble caps because of the hydraulic gradient of liquid flowing across the tray.

A new design, shown in Fig. 1, is claimed to compensate for these irregularities in operation. In the arrangement illustrated, the caps farthest away from the overflow weir are raised off the tray more than the caps closest to the weir. The caps are fixed to a raising and lowering means at each end, which extend through the tower walls. These mechanisms not only permit the slope of the multiple caps to be adjusted from either end but also allow the height of the entire multiple cap assembly to be regulated as conditions of throughput, etc., vary.

The height to which caps are set may be found by observation through glass ports in the tower, by tests on experimental trays, or by calculation. In general, it is stated, the cap sections need be raised a maximum of about 4 inches.

U. S. No. 2,539,142, issued January 23, 1951, to Carl S. Kelly and Shelby Dayton Lawson, assignors to Phillips Petroleum Co., Bartlesville, Okla.

"Blank" Nipple Substitutes for Blind Flange in Smaller Pipe

A "BLANK" nipple for safety shut-off of fuel lines to, for example, process furnaces, is claimed to provide a positive safety device, particularly advantageous for use in such smaller size lines as ¼ to 3 in. pipe, where insertion of the more conventional blind disc and flanged union arrangement is a troublesome and slower routine.

The fitting is simply a short length of rod of the same diameter as the live nipple for a specified line. It is threaded at both ends to connect with conventional threaded union coupling elements on the pipe line being shut off. It has an opening, or slot, cut through the center section at right angles to the longitudinal axis. This slot is for lightening the piece and also to prevent its being drilled and then used as a live nipple.

U. S. 2,537,451, issued January 9, 1951, to William Ferguson, Philadelphia, Penna.

New Design of Breather Roof Developed for Storage Tanks

A FLEXIBLE, non-metallic roof for volatile liquid storage tanks has been designed to serve also as the "weather" roof, thus eliminating the necessity for a separate metallic weather roof or a completely separate breather or vapor vessel. The flexibility permits rising and falling with changes of vapor pressure inside the tank.

The major portion of the roof is the non-metallic material, with a dished, metallic member at the center. Moisture falling or condensing on the roof collects in this central dish and passes down through a pipe in the center of the dish. This pipe telescopes into a lower, vertical drain line which in turn connects with a conventional drainage system at ground level. The telescoping vertical pipes aid in keeping the roof centered. At its lowest position, the roof is supported by girders stretched radially from the center of the tank to the upper rim of the wall.

U. S. 2,537,954, issued January 16, 1951, to Christian Arne, assignor to Chicago Bridge & Iron Co., Chicago, Ill.

Patents Issued in January

The following classified listing covers patents issued during the month of January believed to be of interest or value to petroleum processing or handling operations:

Catalytic Reactors

2,536,402 (Standard Oil Co.—Indiana)—Fluidized solids transfer.
2,537,685 (Standard Oil Development Co.)—Fluidized catalyst apparatus.
2,538,030 (Houdry Process Corp.)—Equipment for moving bed type catalytic conversion with flow control means.
2,539,415 (Hydrocarbon Research, Inc.)—Apparatus for the synthesis of hydrocarbons.

Processing, general

2,536,373 (Universal Oil Products Co.)—Solvent extraction column for use on tar sands, oil shale, lignite, or other hydrocarbonaceous materials.
2,536,436 and 2,538,472 (Phillips Petroleum Co.)—Pebble heating chambers.
2,537,091 (Universal Oil Products Co.)—Waste gas flare stack burner.
2,538,465 (John Marco)—Rotary feed continuous mixer.
2,538,466 (John Marco)—Reactor for homogenizing machines.
2,538,967 (Eastman Kodak Co.)—High vacuum distillation apparatus.
2,539,006 (Union Oil Co. of Calif.)—Adsorption apparatus and process.
2,539,044 (Gulf Research & Development Co.)—Fluid separation apparatus comprising an internal-external gear pump.
2,539,142 (Phillips Petroleum Co.)—Bubble cap fractionator tray.
2,539,699 (Eastman Kodak Co.)—Vacuum distillation apparatus and process.

Tanks and Vessels

2,536,019 (Chicago Bridge & Iron Co.)—Floating roof tank.
2,536,077 (Chicago Bridge & Iron Co.)—Vent for floating roof tanks.
2,537,466 (Allegheny Ludlum Steel Corp.)—

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SIZE RANGE OF GLOBE SEAMLESS WELDING FITTINGS

Description of Fitting	Standard Weight (Schedule 40)	Extra Strong (Schedule 80)	(Schedule 160)	Double Extra Strong
Elbows 45° Long Radius	½ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Long Radius	½ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Elbows 90° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Returns 180° Long Radius	½ in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	3 in. to 8 in.
Returns 180° Short Radius	1 in. to 24 in.	1½ in. to 24 in.	- - -	- - -
Reducers (Concentric and Eccentric)	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 24 x 20 in.	1 x ⅜ in. to 12 x 10 in.	1 x ⅜ in. to 12 x 10 in.
Tees Straight	⅜ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Tees Reducing Outlet	¾ in. to 24 in.	¾ in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.
Stub Ends Lap Joint	1 in. to 24 in.	1 in. to 24 in.	- - -	- - -
Caps	1 in. to 24 in.	1 in. to 24 in.	1 in. to 12 in.	1 in. to 8 in.

Flanges available 1 inch to 24 inches in all weights

Producers of Globe Seamless Stainless Steel Tubes —Gloweld Welded Stainless Steel Tubes—Carbon — Alloy — Seamless Steel Tubes — Globeiron Seamless High Purity Ingot Iron Tubes and Pipe.

Corrosion-resistant lining for vessels, particularly pressure vessels.
2,537,954 (Chicago Bridge & Iron Co.)—Liquid storage tank with a flexible, non-metallic roof.
2,537,986 (Chicago Bridge & Iron Co.)—Seal for floating roof tanks.
2,537,987 & 2,538,067 (Chicago Bridge & Iron Co.)—Support for a seal for floating roofs.
2,538,032-3 (Chicago Bridge & Iron Co.)—Floating roofs.
2,538,059 (Phillips Petroleum Co.)—Internal insulation of vessels.
2,538,875 (Wilbur G. Laird)—Liquid storage tank of floating roof type.

Valves and Fittings

2,536,836 (Leonard C. Bowling)—Valve.
2,537,051 (Specialties Development Corp.) — Quick-acting valve for fire extinguishing equipment.
2,537,450 (General Control Co.) — Throttling reset valve.
2,537,451 (William Ferguson)—Safety nipple for pipe lines.
2,537,470 (W-K-M Co.)—Gate valve of the "through conduit" type.
2,537,563 (Grove Regulator Co.)—Fluid pressure valve-operating diaphragm device.
2,537,809 (Watson-McDaniel Co.)—Steam trap.
2,538,133 (Mueller Co.)—Automatic control valve.
2,538,281 (Leonard L. Snyder)—Valve arrangement for prevention of backflow.
2,538,320 (Allen-Sherman-Hoff Co.) — Rotary valve for transfer of finely divided dry solids.
2,538,896 (Phillips Petroleum Co.) — Quick closing valve and storage tank for handling liquefied petroleum gas.
2,539,106 (The Duriron Co., Inc.)—Plug valve for corrosive fluids.
2,539,614 (Crane Co.) — Peripherally sealed joint for pressure valves, fittings, etc.

Instruments

2,536,089 (W. P. Ratchford and M. L. Fein)—Device for automatic regulation of fluid pressure.
2,536,131 (The Texas Co.) — Radioactivity-actuated device for measuring thickness of solid bodies, level of liquids in containers, density of solids or fluid in containers or flowing through pipe, or position of fluid interfaces in a vessel.
2,536,198 (Taylor Instrument Cos.)—Remote indicating system and transmitter.
2,536,465 (Vapor Recovery Systems Co.)—Remote reading liquid level gage.
2,537,025 (Consolidated Engrg. Corp.)—Mass spectrometer.
2,537,137 (Standard Oil Development Co.)—Rectilinear pen recorder.
2,537,498 (The Liquidometer Corp.)—Totalizing liquid level gage.
2,537,729 (Cameron Iron Works)—Pressure gage.
2,539,069 (Sun Oil Co.)—Cylindrical recording chart construction.
2,539,203 (General Electric Co.)—Noncontacting thickness gage of the radioactivity type.
2,539,418 (Charles H. Grogan)—Apparatus for testing piezoelectric pressure gages.
2,539,665 (Liquidepth Indicators, Inc.)—Liquid level indicator of the pressure gage type.
2,539,843 (Phillips Petroleum Co.)—Pressure vessel testing device, particularly for vessels used for liquefied petroleum gases.
2,539,892 (The Foxboro Co.)—Pressure measuring device.
2,539,925 (Sun Oil Co.)—Outage bob for tank gage tape.

Pumps and Compressors

2,537,349 (James P. Johnson)—Rotary pump of sliding vane type.
2,538,842 (McFarland Mfg. Corp.)—Pump with low and high pressure booster sections adaptable for testing tanks, boilers, etc.
2,539,339 (Ingersoll-Rand Co.) — Controlling device for centrifugal pumps, which changes angular relation of vanes to direction of fluid flow through the pump.

Tools

2,537,175 (Walter Viets)—Ratchet type socket wrench.
2,537,776 (Tube Turns, Inc.)—Equipment for making welded pipe joints.
2,538,006 (Arthur T. Keppler)—Wrench head having distal torque lever.
2,538,176 (Oscar W. Tuepker) — Interrupted thread type, slidable jaw wrench.
2,538,343 (Marshall Van Winkle, Jr.)—Socket wrench head and staking device.
2,538,890 (Atlantic Refining Co.)—Cutter for removing damaged or worn tubes from exchanger bundles.
2,539,262 (Tide Water Associated Oil Co.)—Valve wheel turning tool.
2,539,487 (Metallizing Engrg. Co., Inc.)—Gun construction for blast gas spraying heat fusible materials.
2,539,678 (Ingersoll-Rand Co.)—Impact tool.
2,539,852 (James J. McCoy)—Lever and link feed, worm-adjustable, sliding jaw wrench.

Gaskets, Packing, Seals

2,536,292 (Paul Kollsman)—Rotary fluid pressure seal.
2,538,207 (William J. MacArthur)—Pump shaft packing.
2,538,987 (Aktiebolaget Svenska Kullagerfabriken, Goteborg, Sweden)—Sealing device for shafts.

Laboratory Equipment

2,537,472 (Compagnie Francaise de Raffinage, Paris, France)—Apparatus for carrying out an exothermic reaction at substantially constant temperature.
2,538,710 (Phillips Petroleum Co.)—Apparatus and method to be used in conjunction with conventional fractionation means for analysis of hydrocarbons.
2,538,957 (Pure Oil Co.)—Reflux condenser for fractionating columns.
2,539,082 (M. J. H. E. Hustinx, Maastricht, Netherlands)—Separatory funnel for analysis of oils, fats, soaps, etc.

Miscellaneous

2,537,984 (Foster Wheeler Corp.)—Heat exchange apparatus.
2,538,418 (Infilco, Inc.)—Equipment for regeneration of ion exchangers.
2,539,534 (Phillips Petroleum Co.) — Safety coupling device for electric motor drive shafts.

LUBREX 45

has ideal melting point for greases and harder soaps

LUBREX 45

TITRE . . . . (111.2-114.8°F) 44.0-46.0°C

Color 5¼" Lovibond Column (max.)	35 Yellow—8 Red		
Iodine Value (Wijs)	25	—	35
Free Fatty Acid (as oleic)	100	—	104%
Acid Number	199	—	206
Saponification Value	202	—	209

HARDESTY FATTY ACIDS
• RED OIL
• GLYCERINE
• STEARIC ACID
• WHITE OLEINE
• HYDROGENATED FATTY ACIDS
• STEARINE PITCH
• ANIMAL & VEGETABLE FATTY ACIDS
• PALMITIC ACID

Lubrex 45, a product of Hardesty research, fits the demand for a poly-unsaturate-free fatty acid especially designed for soap and lubricating grease manufacture. The fatty acids in Lubrex 45 are stabilized in our new hydrogenation unit, to give them a greater resistance to heat discoloration. Freedom from polyunsaturated fatty acids prevents rancidity or gum formation from excess unsaturation. No highly unsaturated acids remain to act as agents for polymerization. The melting point of Lubrex 45 has been accurately controlled to give the optimum possible degree of hardness for your precise requirements. Color and uniformity are strictly maintained. Write for details.

W. C. HARDESTY CO., INC.
HARDESTY PRODUCTS ARE INDUSTRY'S KEYSTONE
Established 1926
41 EAST 42nd STREET, NEW YORK 17, N. Y.
Factories: Dover, Ohio • Toronto, Can.

(To obtain more data on advertised products see page 312)

COMPARE

THIS FEATURE

OF THE HONEYWELL SERIES "700" VALVE

✻ Compare the Upper Stem Guide of this valve with that of any other wide band proportional type. Look at it closely . . . study it feature by feature.

Then check the other features of the valve . . . the Specially Designed Diaphragm, the One-Piece Bonnet, the Packless Bellows Seal, the Safety Stem Lubricator, the wide variety of discs, the easy reversibility in the field.

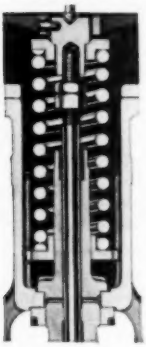
Your comparison will prove that the Honeywell Series 700 has *all* of the features you look for in a fine valve.

It's available in a wide range of styles and sizes. For detailed information, write for a copy of Bulletin 700-3 or call in your local Honeywell engineer . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1910 Windrim Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

New Bulletin 750, "Control Valve Sizing Data," is now available

DUPLEX UPPER STEM GUIDE



Two bearings guide stainless steel upper valve stem. Top bearing is self-oiling; lower bearing is lubricated by an easily accessible grease cup. Continuous lubrication assures almost frictionless super structure responsive to slightest change in signal air pressure.

Specially Designed Neoprene Diaphragm

One-Piece Bonnet

Packless Bellows Seal

Safety Stem Lubricator

Wide Variety of Discs

Reversibility in the Field

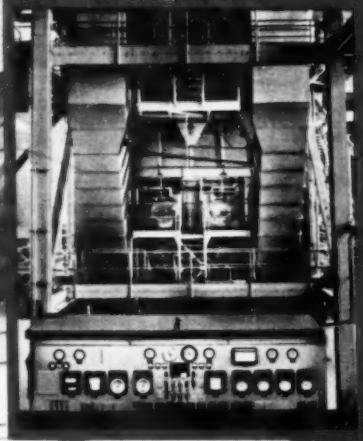
MINNEAPOLIS **Honeywell**

VALVE PRODUCTS

the *complete* engineering service

complete lube oil processing plants

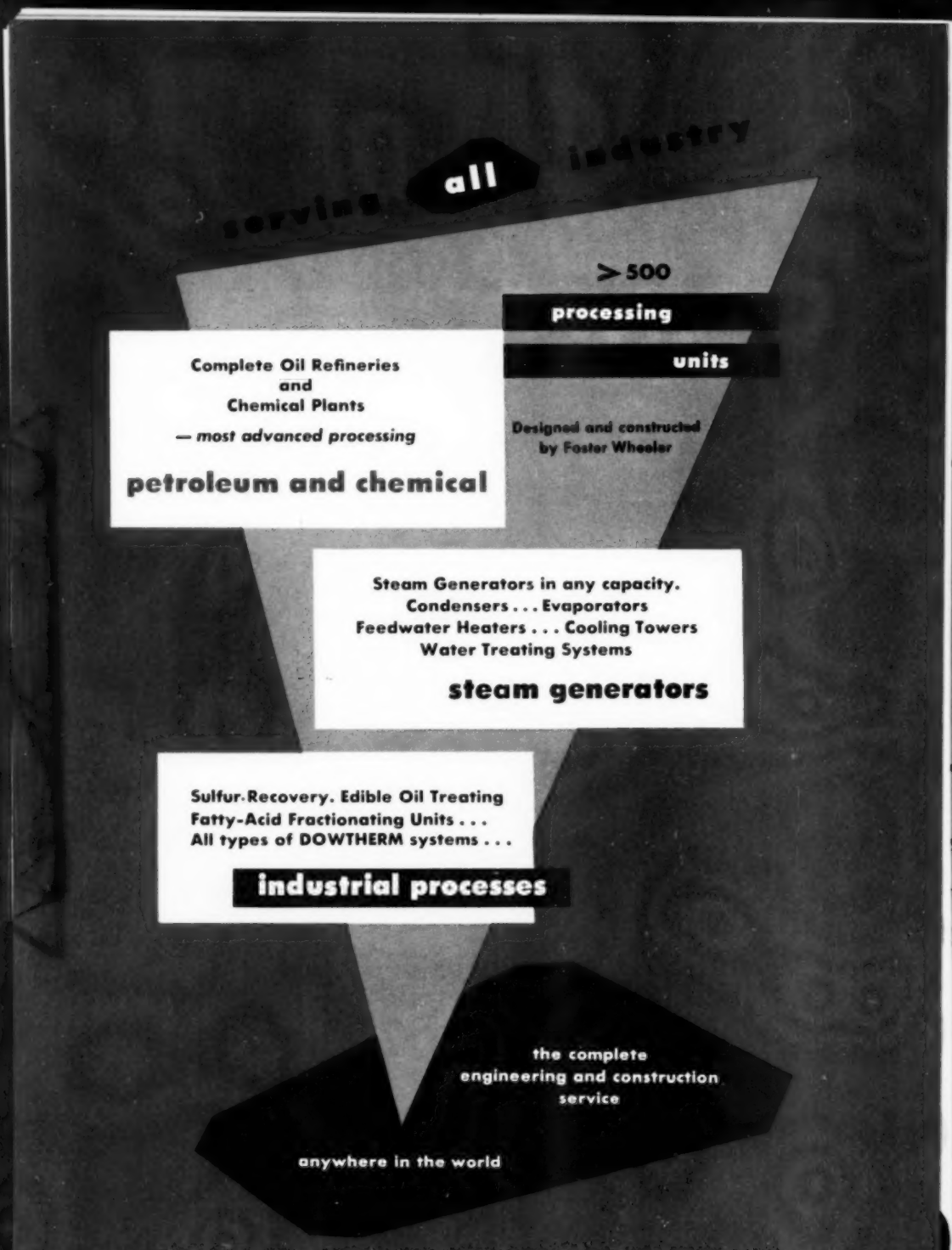
dual-circulation
steam generators



complete chemical plants

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK


serving all industry
>500
processing
units
Designed and constructed by Foster Wheeler
Complete Oil Refineries and Chemical Plants
— most advanced processing
petroleum and chemical
Steam Generators in any capacity.
Condensers . . . Evaporators
Feedwater Heaters . . . Cooling Towers
Water Treating Systems
steam generators
Sulfur-Recovery. Edible Oil Treating
Fatty-Acid Fractionating Units . . .
All types of DOWTHERM systems . . .
industrial processes
the complete engineering and construction service
anywhere in the world

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

NEWS OF SUPPLIERS

Manufacturers
Distributors
Engineering Firms

Cenco Buys Refinery Supply Co.

Purchase of Refinery Supply Co. of Tulsa by the Cenco Corp. has been announced by W. A. Schlueter, president of Refinery Supply, and E. P. Holden, chairman of Cenco and of Central Scientific Co. No real estate was involved in the transaction. Refinery Supply becomes a wholly owned subsidiary of Cenco and will continue to operate as such.

Mr. Schlueter will continue as president of the Tulsa firm. He also joined Central Scientific as a director and vice president. Both companies will enlarge their line by carrying each others products.

Roots-Connersville Elects Owens

Robert H. Owens has been elected president and general manager of Roots-Connersville Blower Corp., succeeding John Avery, who died unexpectedly on January 13. Mr. Owens,

Mr. Owens

Mr. Newquist

a Purdue graduate, joined the engineering staff of P.H. & F.M. Roots Co., the firm's predecessor, in 1925. He was actively connected with the development of the centrifugal line of blowers built by R-C. In May, 1946, he was named vice president in charge of engineering and manufacturing, and in July, 1948, he was elected to the board of directors.

Ralph R. Newquist, who became vice president in charge of sales in May, 1946, has been elected executive vice president. A graduate of Penn State, he was manager of the Washington sales office for Allis-Chalmers Mfg. Co., before joining Roots-Connersville.

Walsh Refractories Expands Plant

Following the recent issuance of a certificate of necessity by National Security Resources Board, Walsh Refractories Corp. of St. Louis is engaged in a major expansion of its fire brick manufacturing facilities at Vandalia, Mo. Objective of the program is to increase annual production by an additional 1000 carloads, or approximately 10 million 9-in. equivalents of fire brick and other refractory products. Completion is expected by early summer of this year.

American Cy Names McDonald

The Industrial Chemicals Division of American Cyanamid Co. has assigned Mr. T. O. McDonald as sales representative for the Gulf Coast. He will specialize in the firm's Aerocat cracking catalysts, Aerolube lubricating oil additives, and Aero specialty catalysts. Mr. McDonald was formerly assigned to the New Orleans office and handled all products of the division. He had served in this capacity since joining the company in 1945.

Mr. McDonald

Prior to joining Cyanamid, Mr. McDonald devoted 12½ years to field production problems for three different oil companies and about six years in oil field sales of general supplies.

Adds Statistical Division

R. S. Aries & Associates, consulting engineers and economists, 400 Madison Ave., New York 17, N. Y., have formed a new statistical engineering division. Under the direction of Frank M. Culpepper, Dr. David B. Hertz, and Dr. Sebastian B. Littauer, the division will specialize in the application of statistical methods to the process industries.

Hughes Coking Process Licensed

Petrocarb Equipment, Inc., 30 Vesey St., New York 7, N. Y., was incorporated recently to specialize in high temperature equipment and refractory constructions for processes including hydrocarbon and certain metallurgical operations.

The company has acquired a license to sell and build the patented Hughes broad oven, used for coking petroleum residues, acid sludges, pitches and tars as well as coking certain coals to give reactive coke. Company will also design and construct other types of high temperature refractory structures, such as retorts and gas heating and cracking units.

Arthur A. Turner, recently elected company president, was formerly with Harbison-Walker Refractories Co. and now is with The Carborundum Co., Refractories Div., as technical sales manager. Vice president Kenneth W. Stookey and Treasurer Jo C. Calhoun are currently president and vice president of Gas Machinery Co. Vice president C. A. Stokes is director of research of Godfrey L. Cabot, Inc. These men will, for the present, retain their current affiliations.

Bell Joins Rust-Oleum Corp.

Roy J. Bell, veteran oil man, has been appointed factory representative for Rust-Oleum Corp. of Evanston, Ill., in Oklahoma and Kansas. He will make his headquarters in Tulsa.

Mr. Bell

Until retiring recently, Mr. Bell was manager of the purchasing and transportation division of The California Co., a subsidiary of Standard Oil Co. of California, in New Orleans. At that time, he had already seen 43 years of active service in the oil industry on the Pacific coast—Gulf coast areas.

Blaw-Knox Appoints Tulsa Man

Kenneth W. Anderson has been appointed petroleum engineer of Blaw-Knox Co.'s Tulsa office. He will be assigned to the oil and gas department of the Chemical Plants Division and will serve the petroleum and processing industries of the Southwest.

Mr. Anderson

A 1938 graduate of Tulsa University, Mr. Anderson has had 12 years' experience in the design and operation of refinery and gasoline plants. He has also worked on special direct-fired furnace designs for the petroleum and natural gas industries.

This door is ALWAYS open

take advantage of Wolverine's open door

You are always welcome here—in our Customer Engineering Service—where we discuss problems that deal with tubing and its various functions.

There's no point in your struggling with a condenser tube problem when you can have the answer so readily here in Customer Engineering Service.

The vast experience of more than three decades of extensive tube-making is represented within this department. And it's all available for you to draw on without cost.

The time to think about the specifications of your condenser tube requirements is *before* you retube—before you encounter difficulties— so you can be sure that your condenser will function at top efficiency.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
INCORPORATED
Manufacturers of seamless non-ferrous tubing
1425 CENTRAL AVENUE • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

EXPORT DEPARTMENT, 13 E. 40th ST., NEW YORK 16, N. Y.

The firm's Chemical Plants Division has moved its Tulsa engineering office to larger quarters at 540 East Fifth St. to accommodate an increasing volume of work.

Procon Elects Gilchrist

Malcolm D. Gilchrist has been elected to the board of directors of Procon, Inc., a Chicago construction firm serving the petroleum and petrochemical industry. Mr. Gilchrist has had wide experience in oil refining both in this country and abroad.

Branches, Distributors

Emery Industries, Inc. has appointed **L. J. Hadobas** to handle direct sales and technical service coverage of the West Coast area for the complete line of their chemical products: stearic, oleic, and other fatty acids, plastolein plasticizers, Twitchell textile oils and soluble oil bases. Hadobas will operate out of a newly established branch office at 420 Market St., San Francisco 11, Calif. Warehouse stocks will be maintained to provide shipments of LCL requirements to West Coast points.

Canadian Ingersoll-Rand Co. Ltd. has moved its Calgary, Alberta, office to 611 Eleventh Avenue West, with larger warehouse and office facilities. Telephone number remains the same, 27813.

Hagan Corp., and its subsidiaries, **Hall Laboratories, Inc., Calgon, Inc.**, and **The Buromin Co.**, has established a new district office at 1463 Monadnock Bldg., 53 West Jackson Blvd., Chicago 4, Ill. Hagan was formerly represented in Chicago by **Burke and Colston.**

Patterson Foundry & Machine Co. has opened a new district sales office in the Majestic Bldg., Denver, Colorado, to provide service to the chemical processing industries in Colorado, Utah, New Mexico, and Wyoming. Office is in charge of Robert Alldredge and William Horblit.

Conoflow Corp., Philadelphia manufacturers of pneumatic control accessory equipment, has appointed **J. R. Simpson and Co.**, 600 So. Michigan Avenue, Chicago, as sales representatives in that city and in Illinois, Indiana, and Wisconsin.

Personnel Changes

E. I. du Pont de Nemours & Co.—Stanley C. Strayer, sales and service representative for the petroleum chemical division, has been transferred from Salt Lake City to Los Angeles.

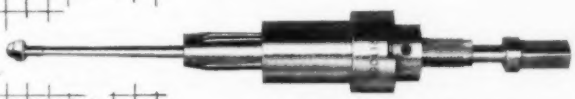
Ladish Co.—E. O. Dixon, with the company for over 20 years, has been

cleans warped and eroded tubes!

The critical metal supply makes this great tube cleaner MORE IMPORTANT THAN EVER. By its use, expensive tubes and pipe that have become filled with coke, warped or worn to a larger I.D. through erosion, can be restored to greater efficiency.

The wing-arm head features an extra long cutting surface. It is especially effective for removing thin hard coke deposits. Maintenance of this tool is simplicity itself as there are no threads on the pins in the wing-arm assembly. A new type holding member on each arm permits the removal of pins without tools.

extra long cutting surface! wide expansion range!



BALL-BEARING TYPE EXPANDERS

Small tube rolling is fast . . . safe . . . inexpensive when these AIRETOOL ball-bearing type expanders are used. A ball-bearing thrust collar reduces friction . . . gives added life to these handy expanders. For full information on any tube cleaning, tube expanding and tube maintenance problem, write The AIRETOOL Mfg. Co., 336 S. Center St., Springfield, Ohio.

for condenser and heat exchanger tubes

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

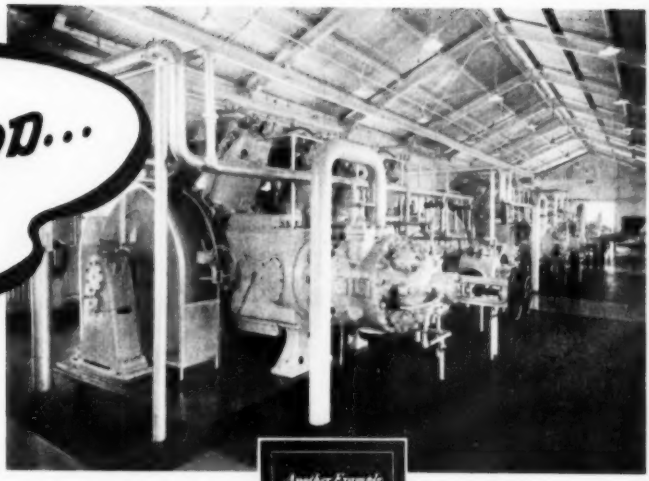
BRANCH OFFICES:
New York, Philadelphia, Chicago, Houston, Tulsa, Baton Rouge
Representatives in Principal Cities

There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction

(To obtain more data on advertised products see page 312)

AT CHITWOOD...

BROAD GAS CONSERVATION with multi-service GMV's



Line-up of four Cooper-Bessemer 8-cylinder GMV compressors, rated 880 hp at 300 rpm, in Magnolia Petroleum Company's Chitwood Gasoline Plant. Here, multi-service operation involves 4800 psi discharge in cycling, 1,015 psi in gasoline extraction, 250 psi for vapor recovery. Flexibility is a keynote.

Another Example of Efficient Power at Lower Cost

GMV's in Magnolia Chitwood plant, shown here from crankdoor side.

Exterior view of compressor building at Magnolia's Chitwood plant.

AT THE Chitwood plant, Magnolia Petroleum Company is doing an outstanding job of gas conservation . . . perhaps unique. The operation includes production of distillate by cycling . . . production of gasoline from casinghead gas . . . vapor recovery off of crude at atmospheric pressure . . . and a pressure maintenance operation.

The operation is of particular interest because it involves both high and low pressures, together with the vapor recovery service — all tied into the same compressor units.

As shown opposite and below, the compressors are efficient Cooper-Bessemer GMV Turboflows — chosen partly because they assure the true flexibility so essential in a multi-service operation such as this.

Whether your plans call for complex compressor service or the most simple kind of set-up, you'll be ahead with Cooper-Bessemer V-Angles. Then you'll be sure of economical installation, prolonged, low-cost performance, and the *flexibility* to meet fixed or variable requirements precisely. Better check with Cooper-Bessemer.

The
Cooper-Bessemer
Corporation

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York, N. Y. Washington, D. C. Bradford, Penna. Parkersburg, W. Va.
San Francisco, Calif. Houston, Dallas, Greggton, Pampa and
Odessa, Texas Seattle, Wash. Tulsa, Okla. Shreveport, La.
St. Louis, Mo. Los Angeles, Calif. Chicago, Illinois Caracas, Venezuela

News of Suppliers

appointed vice president in charge of research and metallurgy; and T. L. Swansen, most recently general superintendent, has been appointed vice president in charge of manufacturing.

Atlas Mineral Products Co.—Ambrose L. Moll, office manager at the main offices in Mertztown, Penna., has been elected treasurer of the company. Earl Erich, formerly of the technical service department, has been made product director for linings and coatings. George Kanelis, a recent chemical engineering graduate of Syracuse University, has joined the engineering department.

Ansul Chemical Co.—David C. Timberlake, a fire protection engineer most recently associated with Underwriters' Laboratories, Inc., has joined the engineering department of the Fire Extinguisher Division. He will work on all phases of dry chemical work, with special emphasis on design and installation of the firm's new automatic piped systems.

Standard Oil Co. (Indiana)—J. E. Kline, who is in charge of engineering sales of lubricating oil additives, has been named head of the Stan-Add Additive division of the company's Sales Technical Service department.

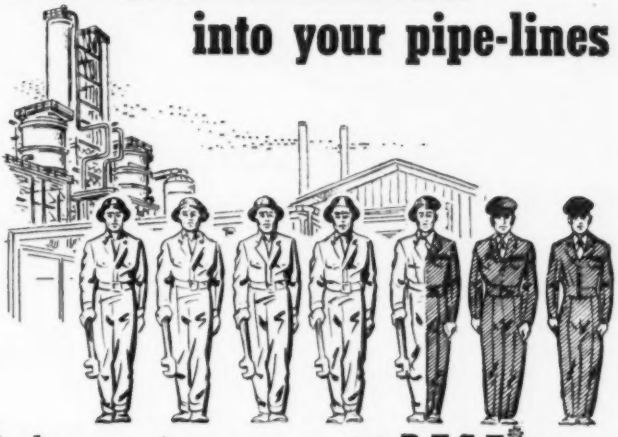
Trumbull Electric Mfg. Co. — Charles Bangert, Jr., who joined the company in 1947 as designing engineer, has been appointed manager of engineering at the main plant in Plainville, Conn. J. J. Pascher, manager of the Hartford office for General Electric Co. since 1945, has joined Trumbull as district sales manager in the New York district.

General Electric Co. — Ralph E. Donnelly, formerly assistant manager, has been named manager of the Fitchburg, Mass., turbine sales division. Edwin H. Howell, formerly manager of sales of the Meter and Instrument Divisions, has been appointed special representative of the company's Apparatus Department in Washington, D. C. Donald E. Craig will succeed Mr. Howell.

American Mineral Spirits Co.—Edward G. Egan has been appointed to head the chemical department of Amsco, where he will be responsible for the sales of the firm's complete line of chemicals. He will be located at the New York office.

Rockwell Mfg. Co.—M. F. Groom and R. J. Munn have been transferred, and W. A. Randle has been added, to the sales staff in the Houston area. Mr. Groom has been in charge of the New Orleans office since joining Rockwell five years ago.

Build STAMINA into your pipe-lines



Reduce maintenance with **D-F S-E*** *Joints*

Shortages of manpower require you to build stamina in your lines. **Directed-Flexing Self-Equalizing*, an exclusive feature of Badger Expansion joints, assures all-curve flexing in the corrugated member. Thus, localized flexing stresses cannot form . . . metal fatigue cut to a minimum . . . breakdowns are virtually eliminated.

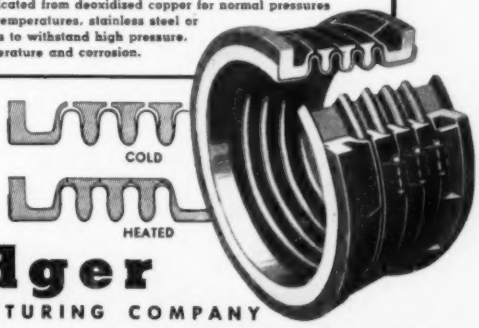
But that's not the whole Badger story. In addition to controlling the flexing movement *within* each corrugation, the specially designed Self-Equalizing Rings also control intra-corrugation movement. For unbeatable stamina be sure you get the exclusive Badger combination — Directed-Flexing Self-Equalizing — when you buy . . . specify Badger Expansion joints for every job.

Only Badger Expansion Joints have Directed-Flexing Self-Equalizing rings which progressively control the movement of the all-curve corrugations.

Plus 5 other big features

- Packless . . . pressure-tight single tube — requires no maintenance
- Compact . . . approximately the size of flanged fitting
- Special forming . . . no structure weakening stresses
- Controlled heat treating . . . assures long life
- Wide range of traverse — pressure — temperature

Fabricated from deoxidized copper for normal pressures and temperatures, stainless steel or alloys to withstand high pressure, temperature and corrosion.

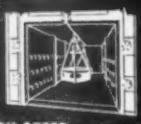


Badger
MANUFACTURING COMPANY
230 BENT STREET, CAMBRIDGE, MASS.

(To obtain more data on advertised products see page 312)

Gradiation

PRECISION TOOL FOR PRODUCTION WAR



HIGH SPEED radiant heat made possible the continuous heat treating of cast armor-plate for tanks with improved metallurgy.

FUNCTION FITTED radiant heat is speeding up forgings by one-third . . . is doubling die life.

DIRECT RADIANT heat has put heat processing of electronic glass tubes on a continuous, precise and automatic basis.

LIQUID HEAT TREATMENT of petroleum and chemicals assures more and better products . . . less space for equipment.

FAST DRYING with radiant heat . . . continuous strip of roofing felt, paper, textiles . . . paints . . . coatings . . . even instantaneous ink drying at paper speeds of 1000 fpm., *plus*.

SELAS GRADIATION offers American industry "*production-engineered processing*" . . . key to improved methods and product quality . . . assurance of new highs in output.

GRADIATION—the newest concept of high-speed heat processing—*proved* during World War II, *improved* since . . . utilizes radiant heat as a precision tool for increased production. Combines high-temperature, automatic operation, precise controllability and protective atmosphere. Where *production* depends on heat processing, let Selas engineers prove *Gradiation* saves manpower, time, material and money.

SELAS CORPORATION OF AMERICA

PHILADELPHIA 34, PENNSYLVANIA

News of Suppliers

Mr. Munn has been in charge of the Corpus Christi offices for several years. Mr. Randle comes to Rockwell from Dow Chemical Co. and McCarthy Chemical Co.

De Laval Steam Turbine Co. — Patrick J. Patton has been appointed Milwaukee manager for the commercial sales division. He will cover the Wisconsin territory, with headquarters at 1932 North 117th Street, Wauwatosa, Wisc. Prior to joining De-Laval in 1950, Mr. Patton was a regional sales supervisor for Worthington Pump & Machinery Corp. Before that, he was a division sales manager for A. O. Smith Corp.

Hooker Electrochemical Co. — J. Herbert Babcock has been named vice president in charge of development and research. He started with the company in 1916 as a research chemist and rose successively through the ranks to his most recent post as director of development and research. He has supervised the development of such new products as dodecyl mercaptan, a modifier for GR-S rubber, organic sulfur compounds for extreme pressure lubricants, and more recently, processes for the manufacture of benzene hexachloride and lindane.

Pacific Gas Corp.—Montgomery F. Woodruff, a field supervising engineer for many years, has been appointed chief engineer.

Billings and Spencer Co. — C. A. Wagner, with headquarters in Dallas, has been named direct representative in Texas, Arkansas, Louisiana, and Oklahoma, for the line of drop forged wrenches and shop tools.

Bigelow-Liptak Corp. — Victor P. Johnson, formerly with M. W. Kellogg Co., has joined the sales staff. He will work out of the direct sales and engineering offices at 50 Church St., New York City.

Dowell, Inc.—A number of personnel changes have been announced in connection with expanding activities at the Fort Worth offices. Marshall L. Stirling, formerly at Tulsa and sales manager of the petroleum division, will head the new Fort Worth office at 907 W. T. Waggoner Bldg. Also coming in to Fort Worth to assist Stirling are Roy W. Allen from San Angelo and Harold L. Ellis from Odessa.

Babcock & Wilcox Tube Co. — David W. Jones, Jr., of Denver, Colorado, has been appointed sales agent in Rocky Mountain area. He will maintain his headquarters at 2600 Forest Avenue, Denver.

There is No Substitute for Experience CHIKSAN
DESIGN
MANUFACTURE
APPLICATION
Only with CHIKSAN Ball-Bearing Swivel Joints* can you benefit from a quarter-century of specialized experience in the development, design, manufacture and application of Swivel Joints for all purposes. CHIKSAN'S resources, facilities and personnel are concentrated exclusively on the production of Swivel Joints and their application to all kinds of installations. This is your assurance of efficient performance, long life and low-cost maintenance. There is no substitute for CHIKSAN!
CHIKSAN Engineers will gladly cooperate with you in selecting the correct Types and Styles of Swivel Joints for your particular requirements...and in specifying the proper Packing Unit for the fluid you handle. This valuable, experienced counsel costs you nothing.
*For full 360° rotation in 1, 2 and 3 planes. Unlimited flexibility in pipe lines can be secured simply by arranging swivels in proper sequence.
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Representatives in Principal Cities
Sold by Leading Supply Stores Everywhere
CHIKSAN
TRADE MARK REG.
BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

(To obtain more data on advertised products see page 312)

IVAN is watching you

IVAN is a dyed-in-the-wool Communist. There are only 6 million party members like him in all Russia, yet these Communist brass-hats enforce the iron dictatorship of the Kremlin over *200 million* Russians.

He's sold to the hilt on Red ideas. Which means he's out to get *you*. He believes it's either you or him . . . that the world is too small for both.

Ivan is working hard to beat you down. He has a big head start.

Right now he's got you in a bad spot.

Ivan is afraid of only one thing.

He fears your ability to out-produce him in guns, tanks, planes.

Frankly, he doesn't think you value your free system enough to do it . . . to make willingly the sacrifices he has squeezed out of the Russians.

But he's wrong!

Because you and all of us have set out to build more and better weapons—to do it faster all the time.

We must use every bit of know-how and inventive skill we have to improve our machines and methods—to turn out more and more for every hour we work. Only in this way can we become militarily strong.

But we've got to supply essential civilian needs as well. We can't allow needless shortages to take prices skyrocketing and lower the value of our dollar.

Sure, that means sacrifices for everybody. But doing this double job well is the only sure way to stop Ivan in his tracks—and to save the freedoms which are ours and which he has never known.

FREE . . . this important booklet tells you how our American System Grew Great

How Americans developed better machines, power and skills to build a great nation . . . Why we have been able to produce constantly more per hour . . . How this has given us the world's highest living standard.

How we can meet today's challenge—Why we must expand our productive capacity . . . supply arms and essential civilian needs, too. Read how this dynamic process works in free booklet, "The Miracle of America," endorsed by representatives of management and labor. Send for your free copy today!

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PETROLEUM PROCESSING

THE BETTER WE PRODUCE
THE STRONGER WE GROW

BOOK REVIEWS

NRC Committee Prepares Report on Laboratory Design

Laboratory Design, edited by H. S. Coleman; 8½ x 11¾ in., x + 393 pages, stiff cloth binding, illustrated, indexed, $12.00. Reinhold Publishing Corp., 330 West 42nd Street, New York, N. Y.

The laboratory as a part of scientific research dates back a good many years, of course, to the days of the alchemist at least. However, little progress was evidenced in improving laboratory facilities and designing them on a more technical basis for many centuries afterward. The magnificent industrial and institutional research centers to be seen today are actually comparatively new buildings. Veteran oil men can recall carrying on research and routine control work in some shanty alongside the refinery office or perhaps in the corner of a pumphouse.

The need for a scientific approach to the problem of laboratory design was recognized some 27 years ago when the National Research Council formed a Committee on the Construction and Equipment of Chemical Laboratories. This group set to work to prepare a reference manual, which finally reached print some six years later, in 1930. In the main, that report dealt with so-called "teaching" laboratories. However, it received widespread distribution and was a valuable factor in effecting scientific thinking on the problem. The NRC Committee continued as a source of information until the great shortage of building materials during World War II put a halt to its work in 1943.

In 1947, the group was re-activated as the Committee on Design, Construction, and Equipment of Laboratories, and specifically charged with compiling a new report to replace the 1930 treatise. *Laboratory Design* is that report. It is divided into four major parts. The first is a general discussion on interior construction materials, furniture, plumbing, light, and power, ventilation, and safety. Part 2 covers teaching laboratories, discussing all phases of their design from site selection to interior arrangements. The third part is on industrial laboratories with chapters devoted to special types and their auxiliary equipment.

The last section contains a series of concise descriptions of various types of laboratories, including plans, sections, and many photographs. The editor has done an excellent job of illustrating this section and the entire book. There are over 150 photographic reproductions and 150 line drawings, sketches, and diagrams within its covers.

Editor Coleman, besides being chairman of the NRC Committee, has been a specialist in this field for many years. He has been assistant director of the Mellon Institute of Industrial Research since 1918, and has authored a number of articles on planning and equipping laboratories. He was in responsible charge of the engineering features in planning and constructing the new building for the Mellon Institute from 1929 to 1937. A large number of contributing editors from industry and educational institutions assisted Mr. Coleman in the preparation of this report.

"Esso Series" Continued with Reference on Orifice Meters

Flow Measurement with Orifice Meters, by Stearns, Jackson, Johnson, and Larson; 7 x 10 in., xviii + 350 pages, stiff cloth binding, illustrated, indexed, $7.50. D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.

Flow Measurement with Orifice Meters is the second in the so-called "Esso Series" by this publisher and is the work of Standard Oil Development Co., the research affiliate of Standard Oil Co. (New Jersey). It is the first dealing with instrumentation problems peculiar to the refining of petroleum. Its purpose is summed up best in the words of the preface, which are quoted in part:

"This book is intended mainly for engineering, technical service, and instrument groups concerned with process control, test work, and plant start-ups in the petroleum industry. Its primary purpose is to provide these groups, in so far as possible, with one reference containing all the information required for the effective use of fixed-area orifice meters in common refinery applications.

"Previous editions . . .have been used within the Company. Because of the demonstrated value of this book to both technical and non-technical personnel, the Standard Oil Development Co. has decided to make it available to practicing engineers, students of engineering, and others who are interested in fluid metering problems.

"Methods of flow measurement with orifice meters are described extensively in reports of the American Society of Mechanical Engineers and the American Gas Association and in manuals furnished by associations of gas producers and by various instrument manufacturers. Experience has shown that these references are not readily applicable to refinery metering, since flow equations are not presented in the most convenient form and since data supplied for flow calculations are often inadequate for this purpose.

"The procedures outlined in this book typify methods currently used in refinery operations, and the physical data presented are limited for the most part to fluids found in petroleum refining. The principles and basic practices are, however, general in nature and may be employed as guides for fluid metering in other industries."

An outline of the chapter headings demonstrates the kind of information given in this book. Included are: derivation of flow equations, applications of flow equations to metering problems, evaluation of variable terms in flow equations, principles of operation of commercial meters, interpretation of meter records, testing and checking meters, meter installations and their accuracy, numerical and physical data.

The authors, Reid F. Stearns Robert M. Jackson, Russell R. Johnson, and Charles A. Larson, are associated with Standard Oil Development Co.

New Fuels Handbook Fills Needs of Combustion Engineer

Fuels and Combustion Handbook, edited by Johnson and Auth; 6 x 9 in., xii—915 pages, flexible binding, indexed, illustrated, $12.50. McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y.

The growth in specialization in the engineering profession— from chemical, mechanical, civil, electrical, etc., engineers to petroleum, plastics, instrument, and combustion engineers, for example—has led to the obvious trend to specialized engineering manuals. One of the most recent of these is *Fuels and Combustion Handbook*.

Covering all forms of fuel, solid, liquid, and gaseous, this handbook discusses their economics, geography, statistics, utilization, preparation and handling, as well as the design and operation of furnaces, boilers, steam generators and accessory equipment for burning them. The section on liquid and gaseous fuels discusses petroleum and its derivatives, liquids other than those derived directly from petroleum, and natural and manufactured gases.

The book is of primary value to the engineer concerned with the use of fuel in today's industrial plants, specifically the combustion engineer. However, it should also be of interest to all petroleum men because of the overall picture it presents of the entire fuels situation. It is an especially well done handbook, in part at least because of the thorough job that was done on the index.

The editors are Allen J. Johnson, consulting mechanical engineer, Lansdowne, Penna., and George H. Auth, professor of mechanical engineering, Villanova College, Villanova, Penna.

TO ALL

NATURAL GASOLINE MEN

GREETINGS

from the

NATURAL GASOLINE SUPPLY MEN'S ASSOCIATION

We are looking forward to seeing you at the

THIRTIETH ANNUAL CONVENTION

of the

NATURAL GASOLINE ASSOCIATION OF AMERICA

April 25-27, Mayo Hotel, Tulsa, Oklahoma

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Woobank Machinery Company
World Petroleum
Worthington Pump and Machinery Corp.
Wyatt Metal and Boiler Works
Young Sales Corporation
John Zink Burner Company

(*To obtain more data on advertised products see page* 312)

Texaco Engine One of Papers At WPRA's Annual Meeting

THE new Texaco knockless engine, a new cracking furnace design for increased conversion ratios, up-to-date information on sulfuric acid alkylation and on petrochemicals in the Southwest are among the featured topics to be covered during technical sessions of the 39th Annual Meeting of the Western Petroleum Refiners Assn. at the Plaza Hotel in San Antonio, April 2-4. An attendance in excess of 1000 is anticipated for this year's meeting.

In addition to three technical sessions, two leading refinery men now associated with the government war program will address the organization during the general sessions. They are Bruce K. Brown, deputy administrator of the Petroleum Administration for Defense, and Reid Brazell, director of the refining division, PAD. Fulton Lewis, Jr., nationally-known radio commentator, will also speak at one of the general sessions. A fourth speaker has as yet not been verified by association officials.

The first paper on the technical program will be a progress report on Texaco Development Co.'s new combustion process and its use in a knock-free gasoline engine. To be presented by Blake Reynolds of Texaco, this paper will discuss some of the economic factors involved in this new engine design. It is based on the continuing study with a single cylinder engine.

In the second paper, "Why Diesel Fuels Behave as They Do," C. C. Ward and H. M. Smith, of the Mines Bureau's Petroleum Experiment Station at Bartlesville, Okla., will present data on a series of composition studies of various crude oils from which Diesel fuels are made.

A new type of radiant heater using flameless cup burners studded in each sidewall of the furnace will be described in a paper by C. C. Tate of Phillips Petroleum Co., Bartlesville. This installation is said to permit adjustment of heat transfer rates at any point, and as a result a time-temperature curve for any specific charge stock can be shaped.

The Phillips radiant furnace has had conversion ratios (gasoline to gas oil) of 40-50 vol.-% and higher when charging virgin and catalytic recycle gas oils on single pass cracking without coil coking, it is reported.

The Southwestern petrochemical industry will be discussed in a paper by George Weber, refining editor, *Oil & Gas Journal*. He will cover some of the points of significance of this industry to the smaller as well as the large refiners.

Social activities will not be neglected at this year's WPRA meeting. They begin at 12 noon, Monday, April 2, with a luncheon and fashion show for the ladies. At 6:30, Monday evening, there will be a buffet supper at La Villita, courtesy of Ethyl Corp.

The association's Spring Party takes place Tuesday evening at 6:30 p.m. This affair and the ladies' luncheon and fashion show are being sponsored through the courtesy of the suppliers and service companies. H. O. Johnson, of M. H. Detrick Co., is chairman.

Wednesday's activities will include a luncheon for all members and guests, at 12:30 p.m., and the annual Dinner Dance at 7:30 p.m.

Technical Session During WPRA's 39th Annual Meeting

Monday, April 2, 2:00 p.m.

Chairman: R. T. Colquette, Pan-Am Southern Corp., New Orleans, La.

"Knock-Free Engine Design — The Texaco Combustion Process," Blake Reynolds, Texaco Development Co.

"Why Diesel Fuels Behave as They Do," C. C. Ward and H. M. Smith, Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla.

Tuesday, April 3, 9:30 a.m.

Chairman: Harry A. Brown, Frontier Refining Co., Cheyenne, Wyo.

"Fire Prevention in Petroleum Refining," Sturgeon Stentz, Pyrene Co., Tulsa, Okla.

"A New Development in Radiant Heating, for the Petroleum Industry," C. C. Tate, Phillips Petroleum Co., Bartlesville, Okla.

Wednesday, April 4, 9:30 a.m.

Chairman: James J. Kelly, Kerr-McGee Oil Industries, Oklahoma City.

"Petrochemicals in the Southwest," George Weber, refining editor, *Oil & Gas Journal*, New York.

"Sulfuric Acid Alkylation for Motor Fuels and Aviation Gasoline," J. W. Jewell and C. C. King, M. W. Kellogg Co., New York.

OIL MAN'S CALENDAR

MARCH

11-17, International Industrial Exposition, Coliseum, Houston, Texas.

12-16, First South American Oil Congress, Montevideo, Uraguay.

13-16, National Association of Corrosion Engineers, Annual Conference and Exhibition, Hotel Statler, New York.

15-16, Two-Day Seminar for Oil and Gas Analysts, Natural Gasoline Assn. of America, Texas Hotel, Ft. Worth, Texas.

19-23, Conference on Industrial Personnel, Dept. of Industrial Engineering, Columbia University, New York.

19-23, 7th Western Metal Congress and Exposition, American Society of Metals, Civic Auditorium and Exposition Hall, Oakland, Calif.

21, Commercial Chemical Development Assn., annual meeting, Roosevelt Hotel, New York.

APRIL

1-5, American Chemical Society, 119th National Meeting (divided), Boston, Mass.

2-4, Western Petroleum Refiners Assn., 39th Annual Meeting, Plaza Hotel, San Antonio, Texas.

2-6, Radioisotopes in Industry Conference, in cooperation with Atomic Energy Commission, Case Institute of Technology, Cleveland, Ohio.

3, Instrument Society of America, Newark Section, 1951 Symposium—Panel Design, Hotel Essex House, Newark, N. J.

4-6, 14th Annual Midwest Power Conference, Sherman Hotel, Chicago.

8-12, American Chemical Society, 119th National Meeting (divided), Cleveland, Ohio.

15-18, 33rd Annual Meeting, Scientific Apparatus Makers' Assn., Greenbrier Hotel, White Sulphur Springs, W. Va.

16-18, American Society of Lubricating Engineers, National Convention, Bellevue-Stratford Hotel, Philadelphia.

17-20, Packaging Institute, 20th Annual National Packaging Exposition and Annual Conference on Packaging, Packing and Shipping, Auditorium, Atlantic City, N. J.

19, Petroleum Committee of Packaging Institute, committee meeting following Technical Committees Luncheon, Ritz-Carlton Hotel, Atlantic City, N. J.

20-21, 17th Annual Engineers' Day, Colorado School of Mines, Golden, Colo.

25-27, Natural Gasoline Assn. of America, Annual Meeting, Mayo Hotel, Tulsa.

30-May 3, American Petroleum Institute, Division of Refining, Midyear Meeting, Mayo Hotel, Tulsa.

30-May 4, 4th National Materials Handling Exposition, International Amphitheatre, Chicago.

30-May 11, British Industries Fair, Castle Bromwich, Birmingham, England.

MAY

6-10, Air Pollution and Smoke Prevention Assn. of America, Roanoke, Va.

7-11, The Greater New York Industrial Show, 71st Regiment Armory, 34th St. & Park Ave., New York.

13-16, American Institute of Chemical Engineers, Regional Meeting, Hotel Muehlebach, Kansas City, Mo.

28-29, American Petroleum Institute, midyear meeting of the Division of Marketing, Cincinnati, Ohio.

28-June 6, Third World Petroleum Congress, The Hague, Netherlands.

JUNE

3-8, Society of Automotive Engineers, summer meeting, French Lick Springs Hotel, French Lick, Indiana.

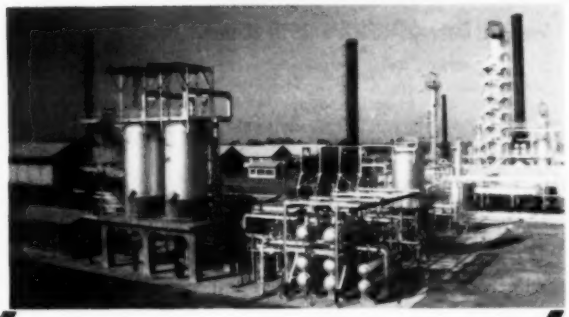
18-22, 54th Annual Meeting, American Society for Testing Materials, Atlantic City, N. J.

SEPTEMBER

10-14, Instrument Society of America, Sixth National Instrument Conference and Exhibit, Coliseum, Houston, Texas.

16-19, American Institute of Chemical Engineers, regional meeting, Sheraton Hotel, Rochester, N. Y.

ANOTHER *Perco** CYCLOVERSION* UNIT



One of the more than 30 Perco Cycloversion units now in full operation is the installation at the new 30,000 barrel per day Petroleos Mexicanos refinery at Salamanca, 150 miles northwest of Mexico, D. F. This 11,600 barrel per day unit went on stream in September, 1950, desulfurizing the straight run gasoline production of this completely modern Mexican refinery.

Write us for complete information on profits in Cycloversion for your own Company. Perco Division, Phillips Petroleum Company, Bartlesville, Oklahoma.

*A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

REFINING TRENDS

Current Data on Crude Runs, Product Supply and Demand

Crude Runs to Stills Hold at Record High Levels in First Quarter of '51

THE first quarter of 1951 will set an all-time peak of activity for U. S. refining operations, higher even than the record for the last three months of 1950.

Total runs to stills reached over 6,500,000 b/d avg. late in February, and indicated runs for that month were 6,430,000 b/d avg., slightly higher than in January. While the Bureau of Mines forecasts a moderate falling off in runs in March to 6,230,000 b/d avg., an average for the quarter of around 6,360,000 b/d avg. is indicated.

This amount is 4% larger than average runs for the last quarter of '50, and it is 18% higher than in the first quarter of '50. For all of last year the average of crude run to stills was 7.6% higher than in 1949. This increased rate of plant operations for the first quarter is greater than the 12% increase in demand for products forecast by the Mines Bureau.

The present high rate of crude runs means refineries continued to be operated at close to capacity. Reporting refineries were operated at 97% of capacity late in February, API basis, and for January and February at an indicated average rate of 95.5%.

The high rate of plant operations has been reflected in the volume of refinery stocks of products. For heating oils 5 months of the normal season of stock withdrawals have been completed. For the refinery districts east of California, refinery heating oil stocks (kerosine and distillate fuels) declined from 92,665,000 bbls. on Sept. 30, '50, to close to 52,000,000 bbls. on Feb. 24, the last figure being based on API data; a total withdrawal of around 40,700,000 bbls. During the 5 months from Sept. 30, '49—Feb. 28, '50, heating oil stocks east of California dropped from 94,800,000 bbls. to 57,500,000 bbls., a decrease of nearly 37,000,000 bbls.

For the country east of California, therefore, the current heating season to date has seen a draft on heating oil stocks at refineries of only around 3,500,000 bbls. larger than in the preceding season. This despite an increase in demand for this product which was 18% larger in 1950 than in '49, and in the first two months of '51 was over 20% larger than the year before. At the present high rate of refinery operations and barring an extremely cold spring, it would appear that the building up of stocks of heating oils against next season's requirements would not be a difficult task for refiners the coming summer, even anticipating an increased demand in the coming heating season. An uncertain factor in demand for distillate products some months hence will be the consumption of jet fuels by this new type of aircraft expected to be coming off the assembly lines in large numbers.

During the same period, Sept. 30—Feb. 28, when refinery gasoline stocks build up against the summer motoring demand, for the entire U. S. stocks increased by about the same volume, around 31,000,000 bbls. in both the current period and that preceding. See Table 1 for details. For the area east of California the increase this year was around 27,800,000 bbls., through Feb. 24 (API basis) as compared with a gain of 26,300,000 bbls. from Sept. 30, '49, through Feb. 28, '50.

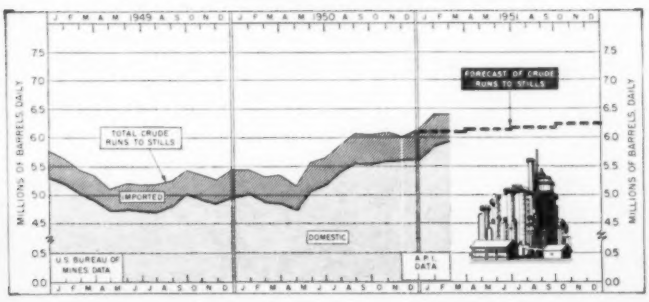
For the area east of California refiners' inventories of gasoline the last of February were around 8,000,000 bbls. higher than the year before. In the face of the increasing motor fuel demand and the growing requirements for aviation gasoline, this addition seems more of a cushion than a possible burdensome inventory.

TABLE 1—Trend in Refinery Gasoline Stocks, Sept.-Feb., by Districts

	Sept. 30 1949	Feb. 28 1950	% Change	Sept. 30 1950	Feb. 24 1951*	% Change
East Coast	23,089	26,872	+16.3	25,155	25,157	0
Gulf Coast	20,294	26,796	+32.0	22,667	32,374	+42.8
Appalachian	3,616	3,986	+10.2	3,691	4,117	+11.5
Ind.-Ill.-Ky	21,696	27,577	+27.1	21,993	30,954	+40.7
Southwest	14,456	21,536	+48.9	15,303	21,940	+43.4
Rockies	2,462	5,075	+106.1	3,143	5,246	+66.9
Total U. S. Except Cal.	85,613	111,842	+30.6	91,952	119,788	+30.3
California	16,186	20,954	+29.5	13,796	17,082	+23.9
Total U. S.	101,799	132,796	+30.4	105,748	136,870	+29.4

* From API Report.

Fig. 1—Domestic Runs Continue Upward


J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
MILLIONS OF BARRELS DAILY
TOTAL CRUDE RUNS TO STILLS
IMPORTED
DOMESTIC
FORECAST OF CRUDE RUNS TO STILLS
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Feb. '51, API*	5,916	514	6,430
Feb. '50, BM	4,878	437	5,315
Change	+1,038	+77	+1,115
% Change	21.2	7.6	20.9

* Through Feb. 24.

Total (1000 bbls.)
(Bureau of Mines Data)

1 Mo. '51*	181,880	17,288	199,168
1 Mo. '50	155,283	14,704	169,987
Change	+26,597	+2,584	+29,181
% Change	17.1	17.6	17.1

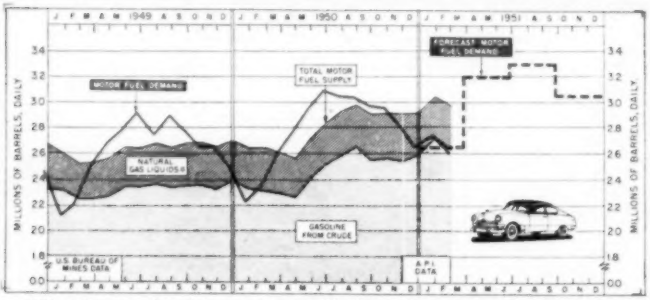
* API data.

BM Forecast of Runs to Stills, 1951
(1000 b/d avg., by Quarters)
1st Q., 6,100; 2d Q., 6,130; 3d Q., 6,150; 4th Q., 6,210

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Feb. '51 API	40.6	6.0	22.0	21.0
Jan. '51 API	41.5	6.2	21.7	21.6
Dec. '50 BM	41.1	5.8	21.3	20.7
Feb. '50 BM	42.7	6.2	19.0	21.7

Fig. 2—High Seasonal Rate for Motor Fuel Demand


J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
MILLIONS OF BARRELS, DAILY
MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
FORECAST MOTOR FUEL DEMAND
NATURAL GAS LIQUIDS
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
API DATA

* Natural Gas Liquids include natural gasoline blended at refineries, and used direct as motor fuel.

Fig. 3—Gasoline Stocks Above 1950 Peak

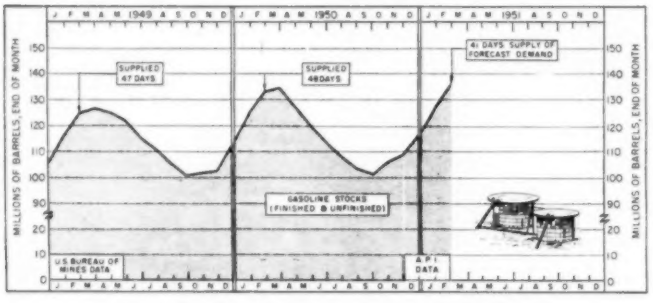

J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 47 DAYS
SUPPLIED 48DAYS
4½ DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
API DATA

Fig. 4—Heating Oil Demand Keeps High

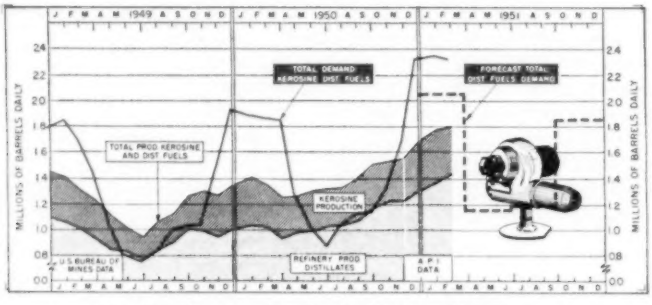
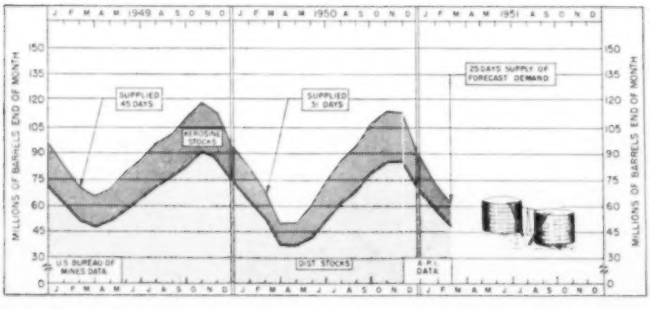

J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
MILLIONS OF BARRELS DAILY
TOTAL DEMAND KEROSINE DIST FUELS
FORECAST TOTAL DIST FUELS DEMAND
TOTAL PROD KEROSINE AND DIST FUELS
KEROSINE PRODUCTION
REFINERY PROD DISTILLATES
U.S. BUREAU OF MINES DATA
API DATA

Fig. 5—Heating Oil Stocks Under 1950 Figure


J F M A M 1949 A S O N D
J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
MILLIONS OF BARRELS END OF MONTH
SUPPLIED 45 DAYS
SUPPLIED 3½ DAYS
25 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST STOCKS
U.S. BUREAU OF MINES DATA
API DATA

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Feb. '51 API*	2,614	350	2,964
Feb. '50 BM	2,310	323	2,633
Change	+304	+27	+331
% Change	13.2	8.7	12.5

* Through Feb. 24.

Total (1000 bbls.) (Bureau of Mines Data)

1 Mo. '51*	82,987	10,943	93,930
1 Mo. '50	72,556	9,466	82,022
Change	+10,431	+1,477	+11,908
% Change	14.3	15.6	14.7

* API Data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Feb. '51 API*	2,604
Feb. '50 BM	2,265
Change	+339
% Change	15.0

* Through Feb. 24.

Total (1000 bbls.) (Bureau of Mines Data)

1 Mo. '51*	82,925
1 Mo. '50	66,876
Change	+16,049
% Change	24.2

* API data.

BM Forecast of Motor Fuel Demand, 1951
(1000 b/d avg., by Quarters)
1st Q., 2,620; 2nd Q., 3,187; 3rd Q., 3,272; 4th Q., 3,043

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Feb. '51 API*	136,870
Jan. '51 API	128,226
Dec. '50 BM	116,769
Feb. '50 BM	132,796

* On Feb. 24.

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Feb. '51 API*	388	1,415	1,803
Feb. '50 BM	338	1,026	1,364
Change	+50	+389	+439
% Change	14.8	37.9	32.1

* Through Feb. 24.

Total (1000 bbls.) (Bureau of Mines Data)

1 Mo. '51*	12,356	43,139	55,495
1 Mo. '50	11,140	32,489	43,629
Change	+1,216	+10,650	+11,866
% Change	10.8	32.7	27.1

* API Data.

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Feb. '51 API*	532	1,788	2,320
Feb. '50 BM	415	1,453	1,868
Change	+117	+335	+452
% Change	28.2	23.0	24.2

* Through Feb. 24.

Total (1000 bbls.) (Bureau of Mines Data)

1 Mo. '51*	16,587	56,283	72,870
1 Mo. '50	14,013	44,282	58,295
Change	+2,574	+12,001	+14,575
% Change	18.3	27.1	25.0

* API Data.

BM Forecast of Heating Oils Demand, 1951
(Kerosine and Distillates)
(1000 b/d avg., by Quarters)
1st Q., 2,039; 2nd Q., 1,143; 3rd Q., 1,185; 4th Q., 1,837

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Feb. '51 API*	12,527	48,764	61,291
Jan. '51 API	15,982	57,728	73,710
Dec. '50 BM	19,723	71,948	91,671
Feb. '50 BM	16,126	52,206	68,332

* On Feb. 24.

Fig. 6—Residual Demand Continues Strong

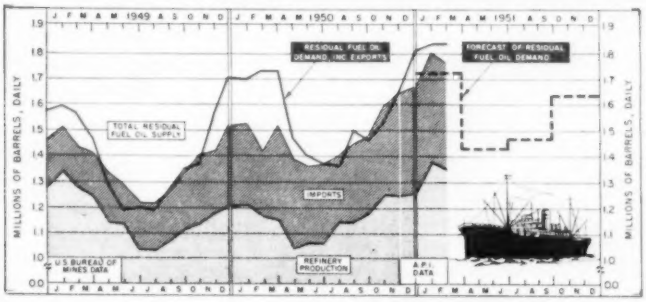
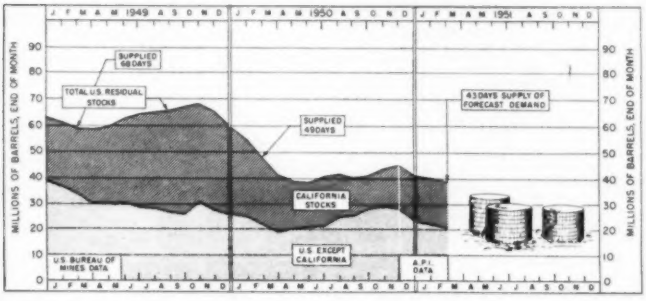


Fig. 7—Little Change in Residual Fuel Stocks



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Feb. '51 API*	1,354	410	1,764
Feb. '50 BM	1,172	253	1,425
Change	+182	+157	+339
% Change	15.5	62.0	23.8

* Through Feb. 24.

Total (1000 bbls.) (Bureau of Mines Data)

1 Mo. '51*	42,893	12,989	55,882
1 Mo. '50	37,491	10,101	47,592
Change	+5,402	+2,888	+8,290
% Change	14.4	28.4	17.4

* API data.

Residual Fuels Demand

Daily Average (1000 bbls.)

Feb. '51 API*	1,827
Feb. '50 BM	1,724
Change	+103
% Change	6.0

* Through Feb. 24.

Total Demand (1000 bbls.)

1 Mo. '51*	56,552
1 Mo. '50	52,512
Change	+4,040
% Change	7.7

* API data.

BM Forecast of Residual Fuels Demand, 1951
(1000 b/d avg., by Quarters)
1st Q., 1,732; 2nd Q., 1,437; 3rd Q., 1,467; 4th Q., 1,641

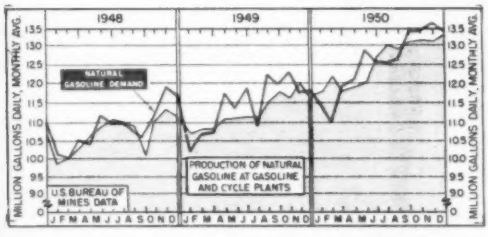
Residual Fuel Stocks

1000 bbls. end of month

	U. S. Except California	Total U. S.
Feb. '51 API*	20,881	38,995
Jan. '51 API	22,893	40,515
Dec. '50 BM	24,143	40,750
Feb. '50 BM	22,034	47,828

* On Feb. 24.

Fig. 8—Production and Demand of Natural Gas Liquids



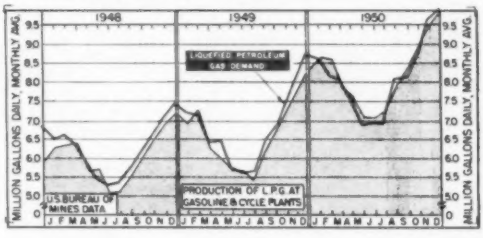
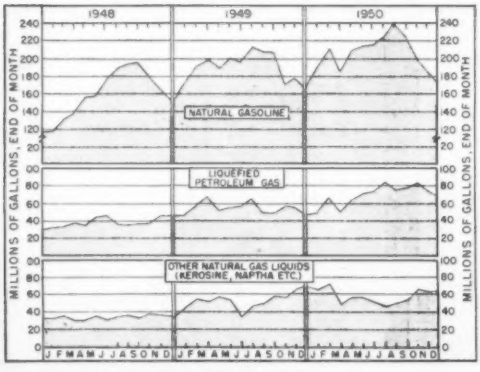


Fig. 9—Stocks of Natural Gas Liquids



Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Production (1000 gal./day avg.) Natural Gasoline	LPG**	TOTAL	Demand* (1000 gal./day avg.) Natural Gasoline	LPG	TOTAL
Dec. '50	13,348	10,004	23,352	13,448	10,143	23,591
Dec. '49	11,700	8,190	19,890	11,774	8,550	20,324
Change	+1,648	+1,814	+3,462	+1,674	+1,593	+3,267
% Change	14.1	22.2	17.5	14.2	18.6	16.1
	Total Production (1000 gal.)			Total Demand (1000 gal.)		
12 Mo. '50	4,605,903	3,019,563	7,625,466	4,585,794	2,981,316	7,567,110
12 Mo. '49	4,167,107	2,430,506	6,597,613	4,194,674	2,444,742	6,639,416
Change	+438,796	+589,057	+1,027,853	+391,120	+536,574	+927,694
% Change	10.5	24.3	15.6	9.3	22.0	13.9

Stocks, End of Month (1000 gal.)

	By Type of Product— Natural Gasoline	LPG	Other Products†	By Location— Refineries	Gasoline Plants	TOTAL
Dec. '50	175,833	69,774	63,293	95,256	213,644	308,900
Nov. '50	183,755	74,628	62,324	97,239	221,477	320,707
Dec. '49	172,207	42,228	65,453	81,228	205,660	286,888

* Demand, including exports but not transfers, is supplied from receipts from outside sources as well as current production and stock changes at gasoline plants. Outside receipts in December totaled 11,634,000 gals.

** Does not include LPG produced at refineries which in December totaled 130,032 gals.

† Includes naphtha, kerosine, specialty and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card. . .no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(A2) ALLIED CHEMICAL & DYE CORP., BAKER & ADAMSON PRODUCTS, GENERAL CHEMICAL DIV. ..... Inside Back Cover

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(A9) BYRON JACKSON CO. 292

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WHAT'S NEW!

Equipment
Materials
Processes
Literature

Reviewed by WILLIAM C. UHL, Equipment Editor

Steam-Detergent Spray Gun Features 12-foot Lift above Operator's Level

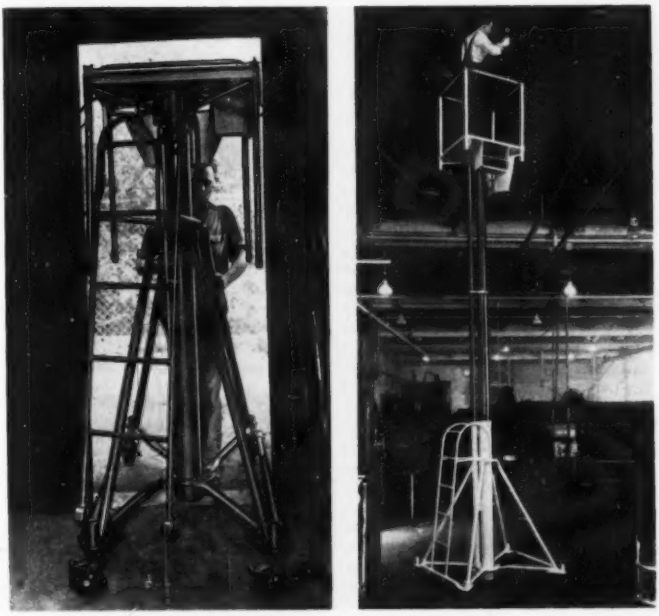
Steam-detergent spray is lifted 12 ft. above working level in the new Model 502 Oakite-Solution-Lifting Steam Gun, designed for use where range of operating pressures (psi. at boiler end of hose while gun is in use) is 50 to 100 psi., with minimum boiler rating of 25 or more hp. recommended. The gun, 7½ ft. long and weighing 15¾ lbs., is equipped with two cast aluminum, spade-type, insulated handles. Forward handle remains stationary, while rear handle manipulates gun. A reinforced rubber apron backs up the steam valve and other hot fittings to protect operator. Swivel coupling for the steam hose connection prevents twisting the hose. Machined seamless steel nozzle has 15/16 in. I.D. and an inner jet. A flat nozzle is also available where wide-angle spraying is desired. Control valves are: ¾-in. globe for steam and ¼-in. globe for solution. Also provided is a cast brass strainer for use at tank end of solution hose. Oakite Products, Inc.

Circle No. **1** *on Reply Card*

OAKITE'S high-lift solution spray gun

Mobile Tower Reaches High Spots or Squeezes through Narrow Doorways

Passage through a door 7 ft. high by 30 in. wide, or full extension to a height of 17 ft. above floor level indicates the flexibility of the electro-hydraulic "Moto-Lift" one-man mobile work tower. Battery-operated and controlled by a foot lever on the platform, the all-metal Moto-Lift has a capacity of 400 lbs., weighs approximately 600 lbs., and permits overhead work on equipment as high as 22-23 ft. Platform is raised through extension of a ram, with the hydraulic pump operated by a battery powered motor. Any standard 6-volt automotive battery may be



SAFWAY PRODUCTS' flexible one-man work tower

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

used. One of 110 amp.-hr. capacity will raise the platform 45 consecutive times on one charge. Platform makes its 10-ft. rise in 25 seconds. Lowering is controlled to one ft./sec. rate. A telescoping safety tube prevents sudden drop in event of complete hydraulic failure. When fully open, base measures 51 in. square, and it folds to 30 x 65 in. for passage through doors. Extended to open position, base is locked with steel pins. Platform has standard safety guard rail, 2 ft., 9 in. high. Tubular steel ladder with handrails is separately demountable. Entire assembly rides on 5-in. casters with rubber tires, each equipped with a positive safety brake on both wheel and swivel. Safway Steel Products.

Circle No. **2** *on Reply Card*

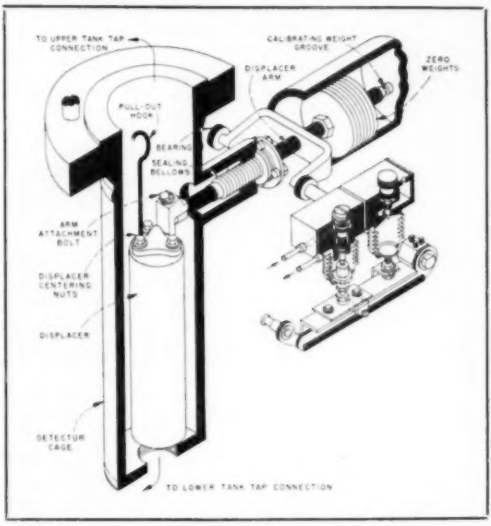
Swing Joint Secured to Tank Shell Reduces Possibilities of Breakage

The new S&J Figure 235 swing joint for petroleum storage tanks features a mounting arrangement which transfers all stresses to the tank shell only. This is said to eliminate the possibility of broken swing joints caused by shifting of the tank bottom with respect to the shell. The joint is of the double elbow type, with a tongue and groove joint between the elbows. The stationary elbow is mounted on the nozzle flange inside the shell. The swivel elbow is held tightly against the stationary one by a spring-loaded rod, making a leakproof fitting. The swivel elbow is provided with a boss which rotates in a thrust bearing welded to the shell by two arms at right angles to each other. During installation, these arms telescope before welding. The design simplifies original installation by avoiding the use of shims. Shand & Jurs Co.

Circle No. **3** *on Reply Card*

Displacement-Type Detector Gives Sensitive Control of Liquid Level

Precise and sensitive control of very small changes in liquid level is provided by a new Honeywell displacement-type detector and transmitter utilizing a bellows seal which can be hooked up with a standard receiver-controller and a diaphragm valve. It is recommended, for example, for refinery fractionators where the rate of withdrawal of bottoms must be carefully controlled to insure uniform flow through the heat exchanger to maintain the fractionator charge at a constant temperature. Wide variations in bottoms flow rate would affect the feed temperature rapidly. The new instrument detects minute level changes and initiates corrective action immediately instead of permitting the level change to become accumulative.



HONEYWELL'S new level controller

Basically, the device comprises two sections—a detector unit and a force balance transmitter. (See sketch) A welded steel detector cage is connected to the vessel in which level is being measured. A stainless steel cylinder displacer in the cage has fastened to its upper end, a rod which extends outside the cage through a stainless steel sealing bellows. The portion of the rod projecting from the cage extends through a yoke and carries removable zero setting weights and terminates with a groove for hanging calibrated weights. Vertical movement of the displacer causes rotation of the yoke shaft, which is supported by self-aligning ball bearings. Rotation of this yoke is transmitted through the base plate by an extension of the yoke shaft.

Mounted on this extension is a lever on the top surface of which is a knife-edged pivot. A small scale on the lever is calibrated in specific gravity. The knife edge is adjustable laterally along this scale to permit the device to be adjusted for specific gravity. A second lever, mounted about the first one, is pivoted at the other end and rests on the knife edge. Mounted above these levers are two bellows assemblies, one for damping the other for balancing.

An increase in liquid level causes momentary upward motion of the float. This results in a clockwise rotation of the yoke, the same of its extension shaft, and, consequently, the lever carrying the knife-edge pivot. The pivot moves the second lever against the pneumatic balancing bellows, thus opening the supply air port and permitting air to enter the bellows. Air pressure increases until sufficient force is created to return all components of the system to their original positions, before the change in level occurred. An opposite sequence of operation takes place if the level decreases. The damping bellows serves to eliminate oscillation, or "hunting."

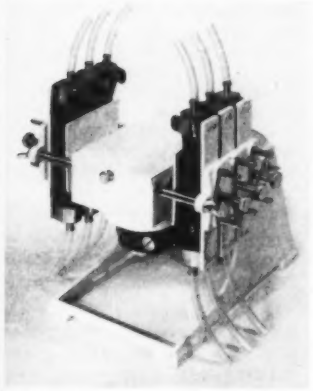
The instrument has the following specifications: ranges; 0-14 up to 0-120 in.; pressure, 300 and 600 psi.; materials, cast steel displacer cage with stainless displacer. Brass, Monel, or plated displacers are available on application. Bellows and trim are of stainless steel. Connections are available for most typical installations. Minneapolis-Honeywell Regulator Co., Brown Industrial Div.

Circle No. **4** *on Reply Card*

Cross-Arm Impactor Easier to Use Than Regular Valve Handwheels

The Edward "Impactor" cross-arm handle is a means for exerting greater force to positively close a valve against high operating or test pressures. It is said to deliver 2.8 times the closing force of regular handwheels. It is currently available on 1¼, 1½, and 2-in. Univalves of 1500 and 2500 psi., and 2-in. Edward hydraulic valves. Application to larger size valves is to be made available later. In operation, two lugs of the cross-arm handle strike equal blows simultaneously against the opposite sides of the small adaptor, which is permanently attached to the valve stem. Wrenches or extension bars are not needed. Handle is cast malleable iron. Edward Valves, Inc.

Circle No. **5** *on Reply Card*



"Six in One" Proportioning Pump Will Meter Liquids up to 500 cc./min.

The Brosites Model No. O, "6 in 1" proportioning pump, designed for laboratory or pilot plant work in the metering of small quantities of liquids, is a combination of six separate pumps operated by a common motor of 1/20 hp., 110 volt, single phase. Each separate pump has a capacity of 1 to 500 cc./min. when the solution is water or a free-flowing liquid. Total capacity of 3000 cc./min. can be obtained when all pumps are operated in parallel. Regulated flow can be obtained from each of the pumps with delivery in desired proportions within the capacity of the unit. Brosites Machine Co.

Circle No. **6** *on Reply Card*

"Ultramax" Buret Offered in Revised Model for Improved, Safer Operation

A revised model of the "Ultramax Buret" has been introduced in which the operation of the Teflon plug has been changed to give positive turning and independent adjustment of pressure. The round knob has been replaced with a hexagonal shape to prevent rolling on a horizontal surface. The knob and lock nut are now made of acid and alkali resistant Vinylite instead of Catalin, as previously employed. New methods of machining the Teflon plug have eliminated the possibility of leakage, and a new process has been employed for the permanent fused-in ceramic scale to insure permanent linearity. The Buret is made of Fischer & Porter precision bore Pyrex brand tubing. Emil Greiner Co.

Circle No. **7** *on Reply Card*

DID YOU MISS THESE?

The following items reviewed originally in "What's New!" in the January issue, have aroused considerable interest among our readers. They are therefore being repeated briefly as a service to those who may have missed them. For details or copies of literature, use the regular reply card in this issue.

Variable-Area Type Flow Transmitter Uses No Mercury or Diaphragms

The "V/A Cell" is a flow transmitter developed for differential pressure applications. It is mercury-less but does not utilize a diaphragm. It is basically a through-flow instrument of the variable-area type which measures a by-passed portion of the main stream. Continuous self-purging is thus provided. A magnetic coupling follows float position and converts flow into proportional air for transmission to receivers. The cell is applicable to services in liquid, gas, and vapor streams (including steam), except for slurries, high-viscosity fluids, and some difficult chemicals. Total differential range is 50 to 1400 in. water; maximum operating temperature is 350° F. Fischer & Porter Co.

Circle No. **8** *on Reply Card*

More Rapid Reset Rate, Rate Action, Provided in New Controller Design

A force-balance, non-indicating controller for pneumatic transmission systems has a circuit said to permit four times faster reset rate and four times faster rate action than conventional instruments. Composite effect of the three responses in the "Transet Tri-Act" controller allows start-up and pneumatic setting with no overpeaking. Faster response settings allow use of rate and reset response, with stability, on processes where these effects were needed but could not be used. The circuit contains two closed loops in series—the first containing fixed proportional response and adjustable rate action; the second with adjustable proportional response and adjustable automatic reset. The unit supplements the "Transaire" temperature and pressure transmitters and the "Miniature Transet" (for graphic panels) recording receivers, to provide a complete control system. Taylor Instrument Cos.

Circle No. **9** *on Reply Card*

Giant Lube Oil Plant

New Horizons, Lummus at Cit-Con; a 24-page pictorial brochure giving a refinery tour in pictures of the Cit-Con Oil Corp.'s new lube oil refinery at Lake Charles, La. The Lummus Co.

Circle No. **10** *on Reply Card*

Fractionating Tower Trays

Glitsch Truss-Type Bubble Trays, Bulletin No. 150; 24 pages of engineering information, drawings, photographs on fractionation column internals, their design, fabrication, and installation. Fritz W. Glitsch & Sons, Inc.

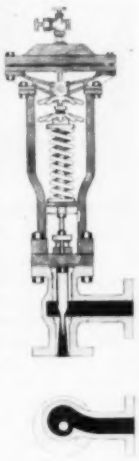
Circle No. **11** *on Reply Card*

Fast Action and Self Positioning Are Features of New Quick Coupling Unit

A new, two-piece, self-positioning, quick coupling unit is said to open and close with less than a quarter turn in less than a second. Consisting of a body with three tapered locking lugs and mating male or female tail piece, the "J. S. Quick Coupling" is available in aluminum, high test bronze, stainless steel, and Ni-Resist alloy. Sizes range from ½ to 6 in., inclusive. It is said to be shock and vibration resistant due to matching taper on the handle ring locking lugs and tail piece locking flanges. Gasket wear is minimized because the flat tail piece face is pressed square against the gasket without twisting action and is locked to the gasket under pressure when the connection is made. Standard couplings take up to 150 psig.; a high pressure model may be obtained for pressures in excess of 2000 psig. Mead Cornell & Co.

Circle No. **12** *on Reply Card*

Boiler Plant Valves Handle Steam And Water at High Pressure Drops



The new line of Swartwout Type V10, flow regulating valves for power plants are designed to handle steam and water at high pressure drops, and especially flashing condensate. Uses include drainage for stage heaters, evaporator coils, flash tanks, process systems, subcooled heaters, boiler blowdown, feed pump recirculation, and other severe service conditions where high-velocity impingement causes frequent maintenance or complete valve replacement. Manufacturer states one of these valves has been in continuous use for over three years with no signs of wear on a high pressure heater drain where 550 psi. condensate at saturated steam temperature flashes to 340 psi. as it passes through the valve. All internals are made of stainless steel, heat treated and precision ground. Valve design, with scroll inlet and gradually expanded straight outlet, eliminates direct impingement and its resulting corrosion-erosion effects. V10 valves are supplied in seven pipe sizes from one to four inches, in 150 to 600 psi. standards; 900-1500 and 2500 psi. standards are also available. The Swartwout Co.

Circle No. **13** *on Reply Card*

Mechanical Packing Made by Coating Each Asbestos Strand with Teflon

"Blu-Lon," Style 320, a new chemically inert mechanical packing, is being offered for such services as sulfuric and sulfurous, chromic, and nitric acids, and most caustics. The material is 100% pure Cape African blue asbestos, entirely free of the usual spinning cotton content. It is coated by the so-called technical suspensoid process with Teflon under 700° F. heat fusion to provide the property of chemical inertness. A. W. Chesterton Co.

Circle No. **14** *on Reply Card*

STORAGE TANKS

paint-stripped in less time—at less cost

SEND for this FREE Booklet. It is full of useful information on general maintenance cleaning. Covers all divisions of the Petroleum Industry—production, processing, transportation, marketing.

BUT FAST—that's how old paint rolls off when you strip tanks the money-saving Oakite way.

Powerful Oakite strippers, applied by hot-flow-on, steam gun, or cold-flow-on method, actually float off paint, dirt and grease. You save time . . . no hand-scraping or chipping. You save money . . . long-life solution may be reclaimed and reused. No expensive sand blasting. And you're safe . . . no fire hazard.

Ask your local Oakite Technical Service Representative for on-the-spot demonstration. Or write for Booklet F7629. No obligation. Oakite Products, Inc., 44C Thames St., New York 6, N. Y.

. . . *Technical Service Representatives in Principal Cities of U. S. & Canada* . . . . .

OAKITE

PETROLEUM SERVICE DIVISION

What's New!

Gas-Pressure Type Extinguishers Are Designed for Dangerous Metal Fires

A pressurized extinguisher designed for hazardous metal fires has been developed and is said to be effective on fires in magnesium, sodium, potassium, zinc, powdered aluminum, and the like.The Ansul "MET-L-X" Dry Powder extinguisher uses an extinguishing agent which fuses to form an air-excluding crust over the burning metal. Small particle size permits its use in a gas-pressure type unit. The powder is moisture-repellent, free-flowing, non-toxic, non-corrosive, and non-abrasive. It does not conduct electricity and will not deteriorate under normal conditions. Manufacturer emphasizes that it is in no way similar to the Ansul Dry Chemical. In order to further differentiate, MET-L-X units are painted bright yellow; dry chemical extinguishers are fireman's red. The MET-L-X units are on Defense Order allocation and not available at present to the general market. Ansul Chemical Co.

Circle No. **15** *on Reply Card*

"Silent Blast" Burner Provides Wide Selection of Flame Sizes and Shapes

The "Precision-Martin" Silent Blast Burner is designed for glass working and other heating jobs requiring a wide range of flame sizes, shapes, and temperatures. Gas flow is controlled by a cock which swings through a 90° arc, full-on at one extreme to shut-off at the other, with minute control of flow in smooth gradations. Gas is delivered to the port not mixed with oxygen or air until it is ignited. A pilot burner on a telescoping shaft facilitates lighting and maintains the master flame. Three interchangeable nozzles are provided—7, 19, 31-ports—to modify the flame from a fine needle point to a brush shape, from

HAVE YOU SEEN THIS NEW BOOKLET?

Condensed information on the function, applications and resultant economies obtainable through this modern development in Entrainment Separation.

The effectiveness of METEX MIST ELIMINATORS has been demonstrated by installations of several years' standing both in this country and abroad. Used in vacuum pipe stills, scrubbing towers, knock-out drums, evaporators and similar equipment and equally adaptable to new or existing installations, they have effected such marked economies as:

1. 95% or better entrainment removal
2. End-product quality secured even with lower-cost raw materials
3. Operation at full capacity without contamination
4. Practical elimination of re-runs

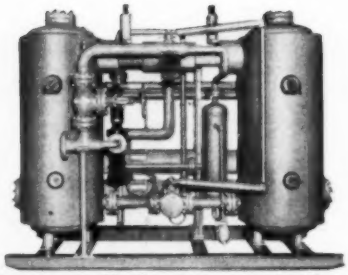
Write for your copy today. The coupon below is for your convenience. No obligation, of course.

QUALITY METEX PRODUCTS

METAL TEXTILE CORPORATION
631 EAST FIRST AVE., ROSELLE, N. J.

Metal Textile Corp.
631 East First Ave., Roselle, N. J.
I would like to have a copy of your new booklet, Metex Mist Eliminators
Name.....Title.....
Company.....
Address.....
City.....State.....

(*To obtain more data on advertised products see page* 312)



Install the New Pritchard

HYDRYER*...

...for Dependable Dehydration of Air and other Gases

Unexcelled for efficiency in drying air for instrument and process controls. Pritchard HYDRYERS are standard packaged units designed to reduce dew points of compressed air and other gases to minus (—) 40° F. Only service connections are required. Specially designed HYDRYER* units can be built to your requirements.

Write for FREE Bulletin No. 16.0.080 *Registered Trade Name

EQUIPMENT DIVISION

J.F. Pritchard & Co.

Dept. No. 71 908 Grand Ave., Kansas City 6, Mo.

District Offices:
HOUSTON • ST. LOUIS • CHICAGO • PITTSBURGH • TULSA • NEW YORK
Other Representatives in Principal Cities from Coast to Coast.

small size...

Yarway Impulse Steam Trap is hardly larger than a pipe union. Easily installed *anywhere.* ½" trap weighs 1¼ lbs.; 2" trap only 8½ lbs. Over 650,000 Yarway traps have been *proved on the job.* Sold by over 200 distributors. For name of nearest one, or free bulletin, write...

YARNALL-WARING CO.
153 Mermaid Ave., Phila. 18, Pa.

YARWAY IMPULSE STEAM TRAP

What's New!

an annealing flame at mild heat to a short, intense flame for glass sealing, ore fusing, and high temperature melting. Burner is adjustable on a ball or socket joint. Overall dimensions are 9 in. high, 9 in. long, and 5 in. wide. Weight is approximately 7 lbs. Precision Scientific Co.

Circle No. **16** *on Reply Card*

Thread and Flange Sealing Compound Resists Hydrocarbons, Refrigerants

"Cyl-Seal" is a new leakproof joint compound for sealing pipe connections said to be resistant to natural gas, butane, propane, gasoline, oil and most solvents, Freon, ammonia, methyl chloride, and oxygen (up to 230° C.). It is applied in liquid form to threaded or flanged pipe connections and changes in the joint to a tough, elastic solid which does not become hard or brittle and has good resistance to vibration and thermal shock. Joints can be easily disassembled without damage. Material is said to contain no lead, graphite, oil, or flammable solvents. Threaded joints made up with the compound have held up at pressures to 2000 psi. without leakage, the manufacturer states. Coverage is good, one gallon making approximately 2000 ¾-in. joints. Cyl-Seal is available in containers from ½-pint brush top cans to 55-gal. drums. Price ranges upwards from $4.10/gal. in 55-gal. drums, F.O.B. factory at West Chester, Penna. West Chester Chemical Co.

Circle No. **17** *on Reply Card*

Trade Literature

Refinery Valve Specifications

Nordstrom Valves, Specifications for Petroleum Refinery Services; stiff cloth, ring-type binding, containing complete set of bulletins with full service conditions and specifications, diagrammatic flow charts, and concise descriptive information on 19 present-day important petroleum processes and their valve requirements. Rockwell Mfg. Co., Nordstrom Valve Div.

Circle No. **18** *on Reply Card*

Lubricating Grease Additive

Santocel ARD in Lubricating Greases, Development Data Sheet; four pages giving properties and other technical data on a free-flowing aerogel, useful in the formulation of greases or other specialty lubricants. Monsanto Chemical Co.

Circle No. **19** *on Reply Card*

What's New!

"Nickel-less" Stainless Tubing

B & W Stainless Croloy Pipe and Tubing, Bulletin TDC 140, covers physical and mechanical characteristics of three non-hardening straight chromium stainless tubing steels, AISI Types 405, 430, and 446; suggested as interesting answers to the problems associated with current restrictions on the use of nickel in steel. Babcock & Wilcox Tube Co.

Circle No. **20** *on Reply Card*

Process Instrumentation

Taylor Technology, Vol. 3, No. 3; includes articles on natural gasoline process instrumentation at Magnolia Petroleum's new Sholem-Alechem plant, on the new Tri-Act controller, on liquid level controlling, and on shop facilities for testing pressure instruments. Taylor Instrument Cos.

Circle No. **21** *on Reply Card*

Flexible Metal Bellows

Flexon Bellows, Bellows Assemblies, Bellows Devices, Catalog CMH-113; 20 page booklet giving specifications, technical data, and typical application for small bellows in brass, stainless steel, bronze, Monel, and Inconel for such services as controllers and instruments, regulators, valves, steam traps, shaft seals, misalignment connectors, and the like. Chicago Metal Hose Corp.

Circle No. **22** *on Reply Card*

Aviation Gasoline Processes

Heat Engineering, January, 1951, includes an 8-page article on catalytic processes and aviation gasoline covering, for example, isomerization, alkylation, catalytic cracking, catalytic reforming, catalytic aromatization. Foster Wheeler Corp.

Circle No. **23** *on Reply Card*

Finned Exchanger Tubes

Brown "Integral One-Piece" Fintubes, Bulletin No. 511; 8 pages of catalog information, listing size ranges, materials of construction, outside surface areas, design curves, and including typical applications. Brown Fintube Co.

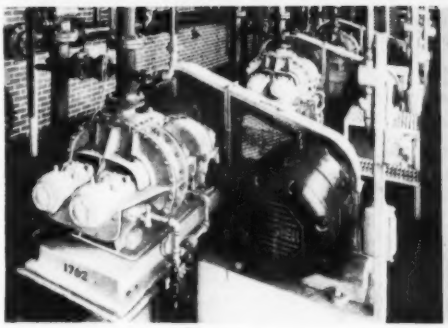
Circle No. **24** *on Reply Card*

Process Equipment Catalog

Patterson Catalog CEC-50; 36 pages describing and illustrating processing equipment and machinery, including agitators, mixers, blending units, synthesizing pilot plant units, etc. Patterson Foundry & Machine Co.

Circle No. **25** *on Reply Card*

NO V-P-L WORRIES WITH R-C BLOWERS



ROTARY

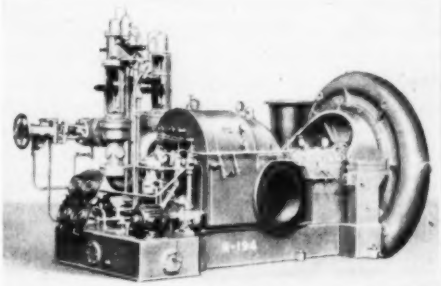
Three of many Type RCG Gas Pumps in processing plant. Capacity of each of these three is 269 cfm.

Today's production urgencies call for "no-vacation" performance from blowers and other equipment to move gas and air. You must be sure of positive Volume, at the required Pressure, and at Low power cost to keep down rising expenses. The answer is Roots-Connersville Blowers with V-P-L.

You can obtain this freedom from worry by installing your choice of R-C Centrifugal or Rotary Positive equipment. This exclusive *dual-ability* gives you the choice of either type to best meet your requirements. Wide latitude in sizes, from 5 cfm to 100,000 cfm, permits selection of units with capacities close to your specific needs. Often, this flexibility saves time, cost, space, weight and power charges.

R-C engineers will gladly counsel with you on any problem of moving or measuring gas or air to keep production going.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Texas Avenue, Connersville, Indiana

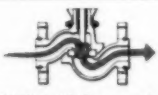


CENTRIFUGAL

Type OIB Gas Exhauster. Capacity 19,000 cfm, driven by 332 hp steam turbine.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

Consistently... **Annin Domotor Valves Improve Performance *and* Save Money In Every Industry!** When you specify ANNIN DOMOTOR Valves you get the benefits of a revolutionary, *but thoroughly field proven and accepted*, valve design that brings you greater benefits than ever before possible. In many industrial applications, a new standard of valve performance has been made possible —opening an entirely new field for instrumentation engineers and control valve buyers alike. ANNIN VALVES SAVE MONEY because they make possible simplified maintenance, reduced inventories, greater utilization. It'll pay you to investigate ANNIN Valves for yourself. Send for an ANNIN Bulletin today!

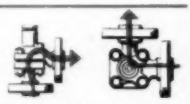


SINGLE SEAT — provides tight shut-off and precision control.

SPLIT-BODY CONSTRUCTION — simplifies maintenance, reduces weight, lowers first cost.

INTERCHANGEABLE FLANGES — increase flexibility, reduce inventories.

SMOOTH, POSITIVE ACTION — BOTH WAYS! Gives precision fluid control, greater stability.



DIRECTIONAL FLEXIBILITY — provides even greater application flexibility without additional cost.

ANNIN DOMOTOR VALVES

THE ANNIN COMPANY 3500 UNION PACIFIC AVE., LOS ANGELES 23, CALIF.

(*To obtain more data on advertised products see page* 312)

What's New!

Gas Synthesis Plant

Crane Valve World, No. 1, 1951; includes a six-page article describing the Bureau of Mines' Gas-Synthesis Demonstration Plant at Louisiana, Mo. Crane Co.

Circle No. **26** *on Reply Card*

Technical Book on Acrylonitrile

The Chemistry of Acrylonitrile, Vol. V of Cyanamid's *Nitrogen Chemicals Digest;* 96-page, hard bound book discussing the synthesis, physical and chemical properties, present and potential applications of acrylonitrile, used in synthetic rubber, synthetic fibers, plastics, dyes, antioxidants, insecticides, etc.; including a bibliography with 580 listings; illustrated, indexed. American Cyanamid Co.

Circle No. **27** *on Reply Card*

Anti-Corrosion Linings

Atlas Corrosion Proof Linings, Bulletin No. 4-1; features a helpful selection table covering line of products for lining concrete or steel to protect against specific corrosives. Atlas Mineral Products Co.

Circle No. **28** *on Reply Card*

Process Heating Units

Fired Heaters for Process Heating, Bulletin B-45, covers a new standard line of direct fired vertical heaters, capacities 100,000 to 15 million Btu/hr., temperatures to 750° F. or above, for direct heating of fluids or indirect circulating heating using heat transfer mediums such as Dowtherm; with automatic controls available. Struthers Wells Corp.

Circle No. **29** *on Reply Card*

Deionization in Water Treatment

Zero Hardness by Amberlite Deionization; folder explains silica and carbon dioxide removal from water by single, or multiple, bed systems of ion exchange, with recommended layouts, case histories, etc. Rohm & Haas Co., Resinous Products Division.

Circle No. **30** *on Reply Card*

Valve Sizing Charts

Sizing Chart, Supplement 3, Catalog 70, covers steam valve sizing for the range from 1 to 1 million lbs./hr. and butterfly valves from 15 to 10,000 gpm. Fischer & Porter Co.

Circle No. **31** *on Reply Card*

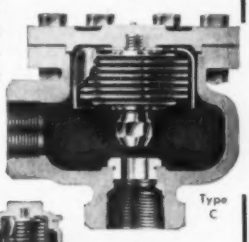
Expansion Joints

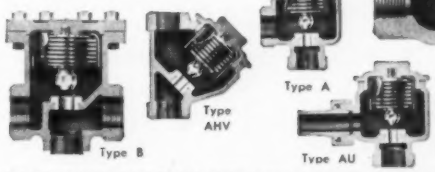
Expansion Joints, Bulletin EJ-1912, 1951 edition, 16 pages on company's Yarway "Gun-pakt" and "Glan-pakt"

Nicholson Steam Traps Require

NO CHANGE of VALVE or SEAT, 0 to 225 Lbs.

Nicholson steam traps save the time and trouble of adjusting valves for varying pressures. This feature substantially speeds production and maintenance. Made of hardened stainless steel, the valve is extra large, resulting in from 2 to 6 times average drainage capacity. Both valve and seat are renewable. The fast action of Nicholson traps prevents waterlogging. Installations have frequently increased production of cooking kettles, for example, as much as 30%. Eliminate "cold blow" in unit heaters. 5 types for every application. Size ¼" to 2"; press. to 225 lbs.





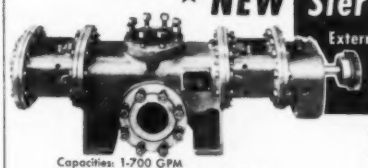
Send for **BULLETIN 450**

W. H. NICHOLSON & CO., 215 Oregon St., Wilkes-Barre, Pa.

★ **NEW** **Sier-Bath SCREW PUMP**

External Gear and Bearing Bracket Type

FOR NON-LUBRICATING LIQUIDS, SEMI-LIQUIDS



Capacities: 1-700 GPM
Discharge: 1000 PSI for viscous liquids
300 PSI for water

★ Greater Dependability
★ Lower Maintenance Costs
★ Longer Life

★ **New Single-Point Alignment** — eliminates bearing strain and rotor misalignment due to change of position of pump elements. Housings for external timing gears and bearings bolted directly to pump body — thus move **with** pump body if it is displaced during installation, or if it expands when handling hot liquids.

★ **New "Dual-controlled" Rotors** — for less wear on bearings and timing gears. **Axial** control by heavy-duty thrust bearings — **radial** control by precision cut timing gears **and** heavy-duty roller bearings.

★ **New Speed in Servicing** — gear housing center line supported, doweled for accurate alignment. All parts automatically positioned by shoulders and locknuts.

PLUS These Regular Sier-Bath Advantages:

No metallic contact between rotors — sustains high volumetric efficiency.

Only suction pressure on stuffing boxes — reduces packing maintenance.

Less strain on valves and piping — minimum cavitation because pump reduces velocity change. Eliminates hammer, vibration.

Direct-connected up to 1800 RPM, Self-priming, Pulseless Discharge.

Available in horizontal or vertical construction, corrosion resistant alloys. Special bodies, stuffing boxes and bearings for high temperature applications. Sier-Bath "Gearex" Pumps for lower pressures and capacities.

WRITE FOR FURTHER INFORMATION

9271 HUDSON BLVD.
NORTH BERGEN, N. J.

Sier-Bath GEAR and PUMP CO., Inc.

Also Makers of Sier-Bath Precision Gears and Gear Couplings

Founded 1905 — Member A.G.M.A.

expansion joints, in sizes to 24-in., including instruction on figuring expansion in pipe and how to figure anchors. Yarnall-Waring Co.

Circle No. **32** *on Reply Card*

AC-DC Test Ammeters

Columbia Tong Test Ammeters, 8-page catalog folder describing operation and use of a test instrument for instant current measurements, either AC or DC, in various models with ranges up to 1000 amps. Columbia Electric Mfg. Co.

Circle No. **33** *on Reply Card*

Combustion Control

Set of five bulletins covering five case histories on combustion control in as many different manufacturing plants; each describing the problems faced, the specific conditions existing, how the system operates, and results obtained: none are petroleum plants, however, load conditions ranged from 10,000 to 120,000 lb./hr. The Hays Corp.

Circle No. **34** *on Reply Card*

Petroleum Processing Index

PETROLEUM PROCESSING *Index for* 1950: includes subject and author indexes for all feature articles and regular departments for the 12 issues published in 1950. National Petroleum Publishing Co.

Circle No. **35** *on Reply Card*

Flange and Coupling Selector

Nooter Flange and Coupling Selector, revised edition, a slide-rule providing such data as O.D. of flange and raised face, thickness, number and diameter of holes, bolt information—for Series 15 and 30 flanges: and average sizes of standard, extra heavy, 3000 and 6000 lb. couplings; including a pipe standard table. The Nooter Corp.

Circle No. **36** *on Reply Card*

Tube Cleaning Equipment

Airetool, Bulletin No. 49; four pages covering the new ball bearing type, Series 6000, air or steam driven tube cleaning motor, with illustrations and data on optional cleaner heads for removing various kinds of deposits in every type of refinery tube. Airetool Mfg. Co.

Circle No. **37** *on Reply Card*

Tank Coatings and Linings

Corrosion Control Coatings, 12-page folder describing vinyl-based thermoplastic resin materials designed as maintenance coatings and tank linings with high resistance to aviation gasoline, diesel oil, crude, lubes, and most petroleum hydrocarbons at room temperatures. Casey & Case Coating Co.

Circle No. **38** *on Reply Card*

High Compression Compressors

Clark Model HBA Compressors, Bulletin 104; 36 pages of technical information on a line of super 2-cycle, right angle, high compression, gas-engine-driven units, in 5, 6, 8, and 10 cylinders, 1100 to 2200 bhp., useful in refinery, natural gasoline plant, pressure maintenance, gas booster, and pipeline services. Clark Bros. Co., Inc.

Circle No. **39** *on Reply Card*

Literature Offered in this Issue's Advertisements

ACTIVATED ALUMINA. Booklet entitled "Activated Alumina—Its Properties and Uses" offered by Aluminum Company of America, Chemicals Division. See advertisement page 324 this issue.
CIRCLE NO. **N4** *ON REPLY CARD*

ANTIOXIDANTS (GASOLINE). A 24-page booklet offered by the DuPont Co. See advertisement page 288 this issue.
CIRCLE NO. **N5** *ON REPLY CARD*

CENTRIFUGAL PUMPS, TLB Bulletin No. 50-9200 offered by the Byron Jackson Co. See advertisement page 292 this issue.
CIRCLE NO. **N6** *ON REPLY CARD*

CENTRIFUGAL PUMPS, 24-page illustrated bulletin offered by Peerless Pump Division, Food Machinery and Chemical Corporation. See advertisement page 239 this issue.
CIRCLE NO. **N7** *ON REPLY CARD*

CONTROL VALVES, Bulletin No. 750 offered by the Minneapolis Honeywell Regulator Co., Industrial Division. See advertisement page 296 this issue.
CIRCLE NO. **N8** *ON REPLY CARD*

CONTROL VALVES, Bulletin offered by The Annin Company. See advertisement page 320 this issue.
CIRCLE NO. **N9** *ON REPLY CARD*

COPPER DEACTIVATOR. Literature offered by Universal Oil Products Co. See advertisement page 286 this issue.
CIRCLE NO. **01** *ON REPLY CARD*

DISTILLATION UNITS (ASTM). Bulletin No. 7-730 offered by the Precision Scientific Co. See advertisement page 284 this issue.
CIRCLE NO. **02** *ON REPLY CARD*

FANS. Literature offered by Hartzell Fan Co. See advertisement page 225 this issue.
CIRCLE NO. **03** *ON REPLY CARD*

HEAT EXCHANGERS. Bulletin No. 481 offered by The Brown Fintube Co. See advertisement page 240 this issue.
CIRCLE NO. **04** *ON REPLY CARD*

HOMOGENIZERS. Catalog offered by Manton Gaulin Manufacturing Company, Inc. See advertisement page 243 this issue.
CIRCLE NO. **05** *ON REPLY CARD*

INSTRUMENT AIR DRYER. Bulletin No. 16.0.080 offered by Equipment Division, J. F. Pritchard & Co. See advertisement page 318 this issue.
CIRCLE NO. **06** *ON REPLY CARD*

MIST ELIMINATORS. Booklet entitled "Metex Mist Eliminators" offered by Metal Textile Corporation. See advertisement page 317 this issue.
CIRCLE NO. **07** *ON REPLY CARD*

OXYGEN ANALYZERS. A 16-page bulletin, No. 50-829, offered by The Hays Corporation. See advertisement page 238 this issue.
CIRCLE NO. **08** *ON REPLY CARD*

PAINT REMOVER. Booklet F 7629 offered by Oakite Products, Inc. See advertisement page 316 this issue.
CIRCLE NO. **09** *ON REPLY CARD*

PIPE FITTINGS. Fitting and Flange Sheets offered by Taylor Forge & Pipe Works. See advertisement page 327 this issue.
CIRCLE NO. **P1** *ON REPLY CARD*

PIPE JACKETING. Literature offered by Chiders Manufacturing Co. See advertisement page 235 this issue.
CIRCLE NO. **P2** *ON REPLY CARD*

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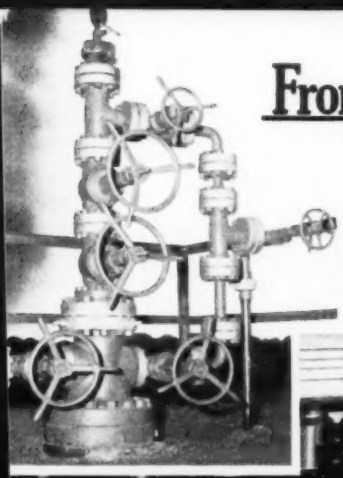

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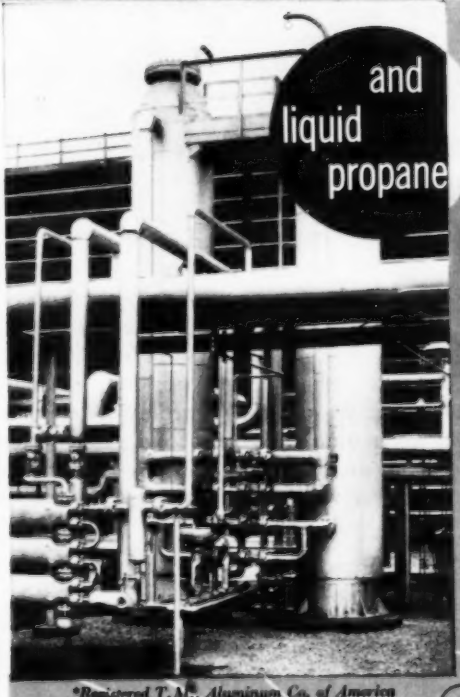

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PERSONALS

Daniel L. Hussey, who joined the company 25 years ago as a student engineer, has been appointed assistant general superintendent of the Bayway Refinery of Esso Standard Oil Co.

He succeeds **Bryant F. Kennedy** who has joined the Standard Vacuum Oil Co. Recently returned from a temporary assignment as process superintendent of the Aruba Refinery, Mr. Hussey has served successively as civil engineer in the General Engineering Department of the Standard Oil Development Company; maintenance engineer, production department head and assistant plant manager of Stanco, Inc., and process superintendent of the Bayway Refinery.

Mr. Hussey

Mr. Kennedy

He was graduated from Worcester Polytechnic Institute in 1925.

Other organization changes include the appointment of **George F. Eustis** as mechanical superintendent to succeed **Jules Verner** who is retiring and **Dale I. Watkins** to succeed Mr. Eustis as assistant mechanical superintendent.

* * *

Dr. Dilworth T. Rogers, of Standard Oil Development Co.'s Research Division, has been named senior research associate. This is in keeping with the company policy of conferring professional titles upon its employes who have rendered outstanding services along technical lines.

Following an initial period of process research work after joining the central research affiliate of Standard Oil Co. (N. J.), in 1938, Dr. Rogers' research activities have been primarily concerned with additives for lubricating oils and fuels. These included detergents, oxidation inhibitors, pour point depressants, viscosity index improvers, and other chemicals. He has collaborated in the publication of various outstanding technical articles, and approximately 60 United States and foreign patents have been issued in his name.

Dr. Rogers attended Rensselaer Polytechnic Institute where he rereceived a chemical engineering degree in 1931 and an M. S. in chemical engineering in 1934. During these years, he was also an instructor in chemistry. In 1937 he received his M. A. in organic chemistry and in 1938 his Ph.D. from Harvard University. While at Harvard, he was granted both the Thayer and the University Fellowships.

* * *

T. J. Gates has been advanced to the post of refinery engineer at the Torrance, Calif., refinery of the General Petroleum Corp.

Mr. Gates has been with General Petroleum since May, 1946. His first post was as a pressure equipment inspector. Since 1949 he has been a maintenance control engineer.

He received a degree in chemical engineering from Wayne University in 1942 and served for four years in the Chemical Warfare Service, holding the rank of Captain upon discharge.

* * *

John A. Scott has been appointed head of the newly created and staffed Petroleum Chemical Division of Sinclair Oil Corp. He joined the Sinclair organization in 1934 as a chemical engineer in the Research and Development Department at East Chicago, upon graduating from the University of Minnesota with a degree in chemical engineering. In 1944 he was transferred to the company's Corpus Christi refinery, where he worked on the design, construction and initial operation of the alkylation unit. Appointed assistant to the vice president in charge of research and development, he came to New York in 1945. He held this position until his most recent promotion. Mr. Scott is an active member of the American Institute of Chemical Engineers and the Society of Automotive Engineers.

Mr. Scott

* * *

Andrew J. Juhas and **Aniello Vicedomini,** both members of the Control Laboratory staff of Tide Water Associated Oil Co.'s Bayonne refinery, have been promoted to supervisory positions.

Mr. Juhas has been promoted to supervisor of the analytical section. He joined the company as an analytical chemist in 1942. In 1944 he was promoted to group leader of the standardization section of the Control Laboratory, the position he held up to his most recent promotion. A graduate of Newark College of Engineering with a degree in chemical engineering, he was awarded his master's degree in chemical engineering by Stevens Institute in 1947.

Mr. Vicedomini, former analytical chemist, has been promoted group leader of the standardization section. He joined the company as an analytical chemist in 1946. He was awarded a B. S. degree in chemical engineering by Lehigh University in 1939.

* * *

T. W. Evans has been elected vice president of Shell Development Co. He was formerly director of research at Shell's Emeryville, Calif., research laboratories. **F. C. Cutting,** former manager of the Manufacturing - Technological Department in New York Head Office, has been appointed assistant to the vice president of the Economic Development Department. **L. R. Goldsmith** has succeeded Mr. Cutting as manager of the department. **G. C. Walker,** former manager of the Alkylation Department at the Wood River, Ill., refinery, has been appointed manager of the Cracking Department. **G. A. Siegelman** has been named to succeed Mr. Walker in the Alkylation Department. He was formerly assistant manager of the department.

Mr. Evans

Holder of a Ph.D. from the University of Washington, Mr. Evans joined the company at Emeryville in 1930 as a research chemist. In 1934 he was moved to Shell Chemical Corp.'s alcohol plant at Martinez to serve as assistant superintendent. Two years later he returned to Emeryville and was named associate director of research in 1942, manager in 1947 and director of research in 1949.

Mr. Cutting is a graduate of the University of Michigan with a Master's degree in chemical engineering. He came to Shell in 1925 as a gas engineer at Tulsa. In the following years he progressed through administrative and operating positions both in refineries and in Head Office-Manufacturing, becoming superintendent of the Wood River Refinery in 1944 and manager of the Manufacturing-Technological Department in 1946.

Following his graduation from the University of California where he majored in petroleum engineering, Mr. Golding joined Shell in 1932 in the control laboratory at the Martinez refinery. In subsequent years

he held various technical and operating positions in the refineries on the West Coast and, in the company's San Francisco office. After serving with the PAW from 1942 to 1944, he became superintendent of the Wilmington refinery in 1946 and remained there until 1949 when he was transferred to the Economic Development Department in New York.

Mr. Walker, holder of an A.B. degree from the University of Colorado, joined the company in 1929 as an analytical chemist in the Wood River refinery's control laboratory. He was named manager of the Dispatching Department in 1945 and two years later was appointed to his former position.

A graduate of M. I. T. where he majored in chemical engineering, Mr. Siegelman entered Shell's organization as a junior technical assistant in the research laboratory of the Wood River refinery. Entering the military service in 1942, he returned in 1946 as a technologist at this refinery. In 1947 he became senior technologist and was made assistant manager of the department he now heads in 1948.

* * *

K. E. Kingman manager of manufacturing for Union Oil Co. of California, has been named to the company's board of directors. A graduate of the California Institute of Technology with a degree in chemical engineering, Mr. Kingman joined Union in 1929 as a junior chemist and advanced through several assignments to junior engineer by 1932. He was an engineer in the development department from 1932 to 1935 when appointed assistant superintendent of operations at the Los Angeles refinery. Two years later he was transferred to Union's Oleum, Calif. refinery, became manager of the Los Angeles refinery in 1949 and manager of the manufacturing department in 1949.

* * *

Ralph R. Matthews, former executive vice president of Battenfeld Grease and Oil Corp., is executive secretary of the Independent Oil Compounders Assn., whose headquarters are at 5040 Brookside Blvd., Kansas City. The association was organized in 1948 in St. Louis and held an annual meeting that fall in Chicago. One of its prime objectives is to promote technological improvements among its members in the compounding and manufacturing of lubricating oils and greases. Mr. Matthews had been with the Battenfeld company for over 20 years before his retirement. He is a widely recognized lubrication authority and is a contributor to PETROLEUM PROCESSING on that subject.

* * *

Joseph E. Carney has been appointed assistant chief metallurgical engineer of Sun Oil Co. He joined Sun's metallurgical department at the Marcus Hook refinery in May, 1934, and was named chief inspector of the department about ten years ago.

Mr. Carney received a B. S. degree in chemical engineering at the University of Pennsylvania in 1928 and worked for the Midvale Co. in various engineering capacities before beginning his career with Sun.

* * *

H. M. Noel, process engineer for Esso Laboratories, Standard Oil Co., Elizabeth, N. J., won the top award in the Regan Forge and Engineering Co. "International Contest" conducted during the annual API meeting. The award was a 19 jewel, 14 kt. solid gold case Hamilton wrist watch. To qualify for the award, Mr. Noel correctly translated ten Regan testimonials and identified the language used.

* * *

Robert E. Wilson, chairman of the board, Standard Oil Company (Ind.) has been appointed chairman of the Committee on Research of the National Association of Manufacturers.

The committee, which until 1951 was a sub-committee of the NAM Committee on Patents and Research, was organized to consider questions and problems of industry relating to science and technology, and to advise the NAM on policies relating to scientific and technological matters. The membership consists of 150 scientists and research workers from industrial companies throughout the nation. Dr. Wilson is a national vice president of the NAM.

* * *

H. J. Monnik, chief engineer, Catalytic Construction Co., has been named project director of Catalytic's Atomic Energy Division.

Mr. Monnik has been Chief Engineer and director of the Catalytic Construction Co., since its formation in 1946. Prior to this, he had been associated with the Sun Oil Co. in its engineering department for fifteen years, starting as a draftsman and advancing to a senior project manager. In the latter capacity, he was responsible for the mechanical development of many important innovations in oil refinery equipment. Mr. Monnik has been identified with the development of Houdry - Catalytic Cracking Plants since their pilot plant stage in 1935.

He is a graduate of Rensselaer Poly. Inst. with a degree in Chemical Engineering.

* * *

Three employes of the Tide Water Associated Oil Co. refinery at Bayonne, N. J., who have retired after more than 50 years each with the company, have been honored at a luncheon at the Downtown Athletic Club, New York. They are **John Krzywoszynski, Elliott Russell** and **Thomas W. Welcher.**

Gold watches were presented to each by Vice-President **B. I. Graves,** director and chairman of the company's eastern division operating committee.

* * *

D. P. Parker, manager of the technical and engineering division at Socony-Vacuum's Lubrite plant, E. St. Louis, is on temporary loan with seven other Americans as his crew to Vacuum Oil Co., Ltd. during construction of the Coryton refinery (see What's Happening, April, 1950, p. 319), where he is in charge of technical and engineering matters. "It is very interesting," he wrote, "to start with the fill and go on from there," since the plant will be almost new.

* * *

Socony-Vacuum Oil Co., Inc., has announced the award of $2,000 to the Department of Chemistry, **Lehigh University,** Bethlehem, Pa., for continuation of a fellowship in analytical chemical techniques during the period from Feb. 1, 1951 to Feb. 1, 1952.

A total of 20 fellowships will be supported by Socony-Vacuum during the 1951-52 academic year at colleges and universities throughout the country at a total cost of $40,000.

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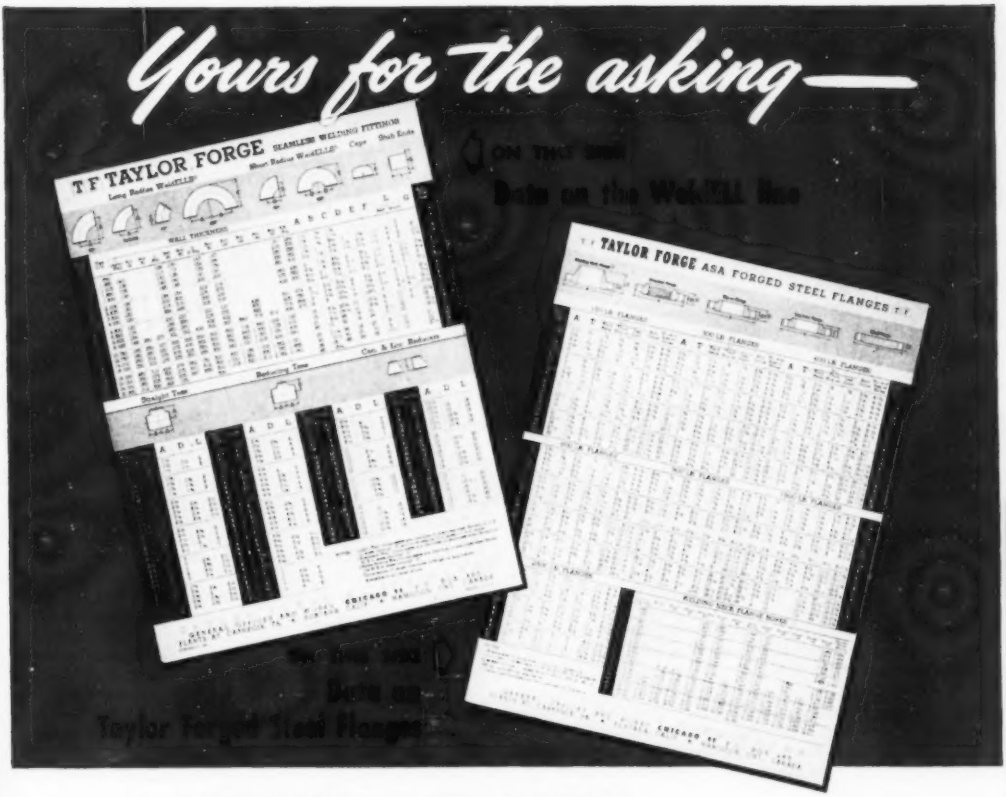

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EDITORIAL VIEWPOINTS

Opinions and Comments on Current Topics

Still Fumbling Our Greatest Asset

EIGHT months of war and well into rearmament finds the military authorities without a plan for making effective use of the scientific manpower of the nation in our mobilization program. The lack of understanding and the delay on this subject in Washington is hard to comprehend. Certainly World War II established the vital need of technically skilled workers in industry to achieve the mass production of weapons of warfare incorporating new developments in science and engineering.

The need for making the most strategic use of all available scientific and specially skilled manpower in our rearming against another possible world conflict is greater now than in the last war. The number of men in industry with engineering and scientific training and with other specialized capacities who are subject to military call is much larger. In the petroleum industry there are 200 times as many military reservists as in 1941. Already many of these men have been recalled into non-specialized military duties.

If our military forces take the field in full scale it will be against enemies whose total manpower we cannot hope to match. Our chances for success, perhaps even for survival, will lie in making the fullest effective use of our industrial "know-how" to achieve overwhelming superiority in weapons. The "know-how" can come only from the scientific and technically trained manpower in industry, employing the skill that experience brings. By the side of these men must be others trained in research, who invent and develop not only new weapons but also the new tools and techniques which industry uses to improve its operations. Equally important in any long-range rearmament program must be the provision for selecting and educating in the critical sciences an adequate number of young men to replace the present professional workers in industry as their service ends.

To end this draining away of our most valuable asset in rearming, through indiscriminately taking into the Armed Services both present reservists and inductees under Selective Service, the Scientific Manpower Advisory Committee of the National Resources Security Board has proposed a constructive and inclusive plan for the development and use of scientific manpower which can be keyed into a universal military training law. The Committee's program (reviewed on pg. 262) has three recommendations: (1) to maintain a continuous flow of students in training in critical scientific fields essential both to military and supporting civilian activities; (2) to establish properly qualified boards to allocate the available scientific manpower to both the Armed Services and essential civilian pursuits and (3) calling on the Defense Department to arrange means to insure the deferment of present military reservists in positions vital to defense production.

This three-point program has been presented before the Senate Armed Services Committee in hearings in Washington on the bill which will replace the present Selective Service Act expiring in July. The time is indeed short to impress upon Congress the urgency for including in the new law provisions for the strategic use of the nation's scientific manpower. Therefore, refiners and others in the petroleum industry should make greater efforts to give Congress their views. The sooner such provisions are incorporated in the military training law the greater the safeguard to the nation's future.

Maintenance Readies for Long Pull

THE upkeep of operating units in refineries and gasoline plants in the mobilization period, fortunately, does not face the same critical problems that beset the plants at the start of World War II. Then many important maintenance items disappeared from suppliers' warehouses almost overnight. Replacement equipment such as pumps, motors and so on was frozen, to be allocated under strict priority to wartime plant construction.

At present many maintenance materials are still available. However, the fact that our rearmament program is planned to extend over several years, with shortages not experienced today becoming progressively more acute, should be reflected in the current activities of the maintenance staff. The proper steps taken now can anticipate and alleviate many future difficulties.

Inventories of equipment in use and stocks of replacement and repair parts should be carefully studied to see how long they can be made to last. Manufacturers' recommendations and accepted plant maintenance practice should be reviewed to make sure that even small points affecting the life of the equipment, such as proper lubrication, for example, are being properly followed.

Australia's Shale Oil Plant Closes

ONE of the world's few commercial shale oil ventures, at Glen Davis, New South Wales, Australia, has shut down as a losing venture, despite its location in a continent entirely lacking in oil production and depending solely on imports for its requirements. Financed both by private capital and government subsidy, the plant, which had been in operation since 1940, produced at the most some 2,700,000 gallons of gasoline annually, at a cost of 56 c/gal. During the war, a technical mission from this country went over to advise what could be done to improve the Glen Davis operations.

Australia, like this country, has large deposits of rich oil shale. Perhaps that is as far as a comparison can go between the shale oil venture there and the proposals for commercial plants here to augment petroleum supplies on the West Coast. The best we have here in estimates of costs for mining shale and refining the oil are those of the Bureau of Mines, based on economic studies in its synthetic liquid fuels program. In view of the magnitude of any commercial projects undertaken, Congress could well consider sending competent authorities to study the reasons for failure in Australia, and the mission should include other than Bureau of Mines technologists.

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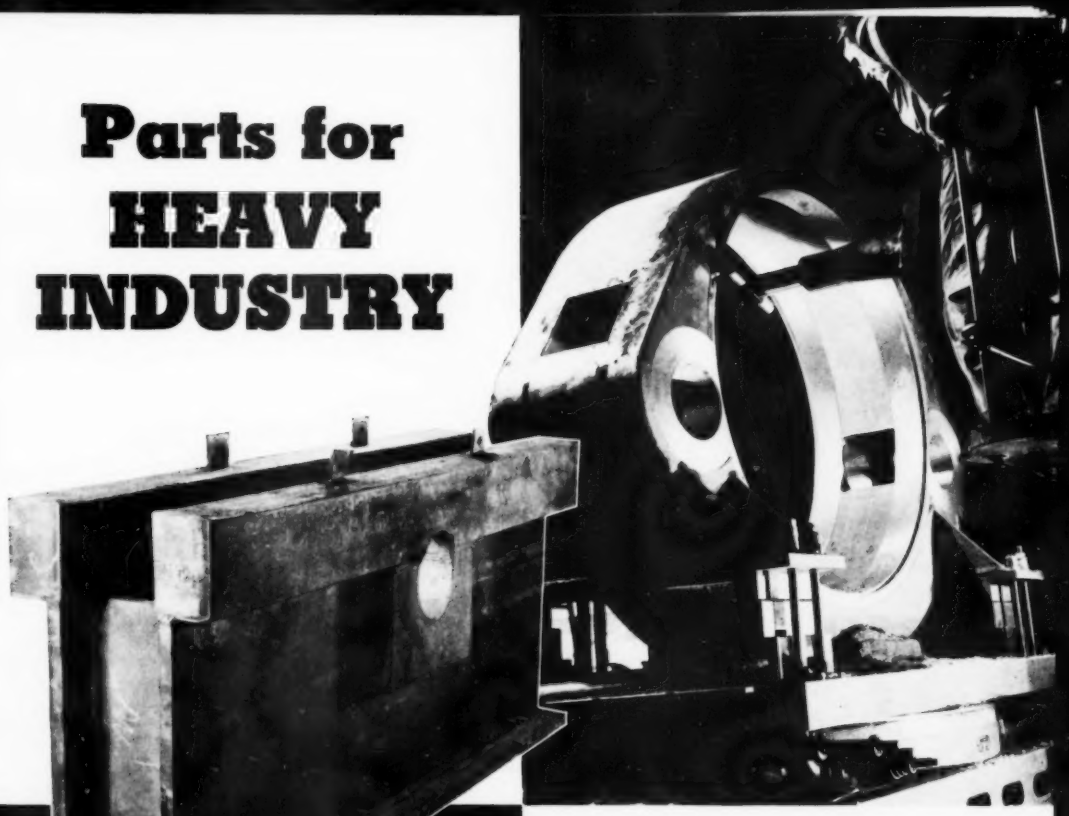

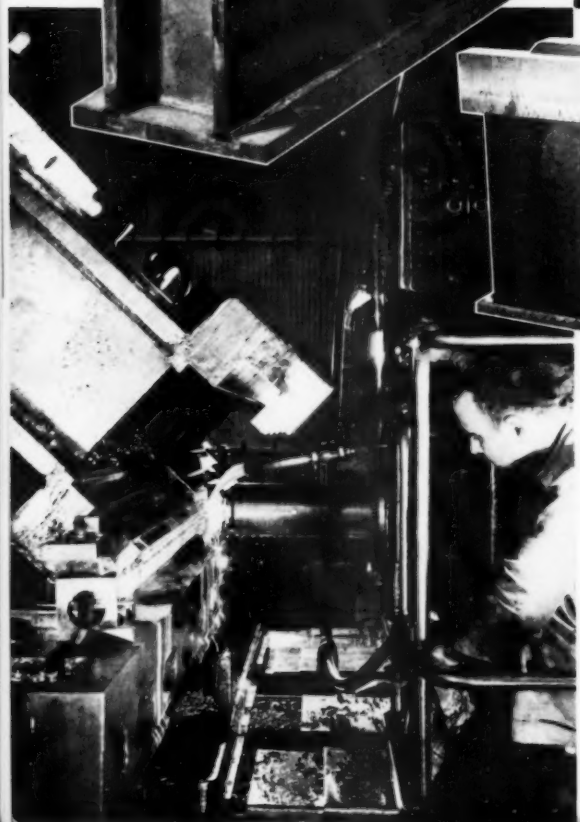

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